Science and Technology for Chem-Bio Information Systems (S&T CBIS)
"Translating Lessons Learned into Systems Requirements"

25 -28 October 2005

Agenda

Tuesday, 26 October 2005 - General Session

Keynotes:

- Systems Perspective on Information Systems, BG Stephen V. Reeves, USA, Joint Program Executive Officer for Chemical Biological Defense
- Chemical and Biological Technology for the Joint Warfighter, COL Benjamin Hagar, Joint Science & Technology Office, CBDP, and Chemical and Biological Technologies Directorate, Defense Threat Reduction Agency
- Joint Requirements Office for Chemical, Biological, Radiological, and Nuclear Defense (JRO for CBRND), LTC Mark Bohannon, VC, USA

Technology Transition Overview - How do I get the Cheese?, Mr. Curt Wilhide, Chief, Advanced Technology and Transition

Joint Project Manager Information Systems Program Overview, CAPT Tom O'Keefe, USN, JPM Information Systems, Joint Program Executive Office for Chemical and Biological Defense

Joint Effects Model Program Overview, Mr. Tom Smith, JEM Acquisition Program Manager

Joint Operational Effects Federation Program Overview, Dr. Jerry Hoffman, JOEF Acquisition Program Manager

Joint Warning and Reporting Network Program Overview, Mr. Chuck Walker, JWARN Acquisition Program Manager, Joint Project Manager Information Systems

Joint Project Manager Information Systems Integration Overview, Mr. Kevin Adams, JPM IS Lead Integrator, SSA Director

Joint Science and Technology Office Program Overview, Mr. Chuck Fromer, Joint Science and Technology Office for Chemical and Biological Defense (JSTO-CBD)

Environmental Hazard Prediction Thrust Area Overview, Mr. John Pace, Joint Science and Technology Office, Defense Threat Reduction Agency

Operations Effects Thrust Area Overview, Mr. Mark Fagan, OETA Manager

Battlespace Management Thrust Area Overview, Mr. William J. Ginley, Battlespace Management Thrust Area Manager, Edgewood Chemical Biological Center

Wednesday, 27 October 2005 - General Session

Agent Fate Program Overview, Dr. James Savage, Research Development and Engineering Command, ECBC

CBDP Decision Support Tools and Methodologies, Mr. Scott Cahoon, Defense Threat Reduction Agency

BREAKOUT SESSION A
***Working Group I** - Dispersion Modeling and Sensor Data Fusion:*
Session A-I Agenda

- Overview of Hazard Prediction Modeling Program, Mr. John Pace, Joint Science and Technology Office, Defense Threat Reduction Agency
- RCB Weapon Environment Prediction: Source Term Estimation, Mr. Paul Thomas, Mr. Peter Robins, and Ronni Rapley
- High Level Architecture Compliance: Source Term Estimation Demo, Mr. Ian Griffiths, Mr. Andrew Solman, and Mr. Ben Swindlehurst
- STEM II Bio Data *(Video)*
- Mobil Array *(Video)*

***Working Group II** - Chemical Agent Persistence and Prediction Modeling:*

Session A-II Agenda

- Droplet Reaction and Evaporation of Agents Model (DREAM), Mr. A.R.T. Hin, TNO, The Netherlands
- Chemical Agent Fate Program (CAFP): Development of an Evaporation Model for HD on Non-Porous Surfaces, Mr. Brad Dooley, California Institute of Technology and H. K. Navaz, Kettering University
    - Sample Animated Droplet Topology - 1 L Droplets *(Video)*
    - Sample Animated Droplet Topology - 6 L Droplets *(Video)*
    - Sample Animated Droplet Topology - 9 L Droplets *(Video)*

- Applying Quantum Chemical Theory to the Fate of Chemical Warfare Agents, Dr. Tom J. Evans and Dr. Tom Stark, Cubic Applications, Inc.

Working Group III - *Battlespace Management****:***

Session A-III Agenda

- CB Defense Battle Management, Mr. William J. Ginley, Battlespace Management Thrust Area Manager, Edgewood Chemical Biological Center
- Next Generation Chem Bio Battle Management System, Mr. Jim Reilly, AFRL/IFSA

Working Group IV - *Decision Making and Support****:***
Session A-IV Agenda

- Analytical Capabilities Development, Dr. Jeffrey Grotte, Institute for Defense Analyses
- Virtual Prototyping Feasibility/Benefit and CB Common Knowledge Base BA05MSB061, Mr. Michael Kierzewski, ECB, and Mr. Scott Kothenbeutel, Battelle
- DTRA -Modeling and Simulation/Battlespace - BO05MSB070: Multivariate Decision Support Tool for CB Defense, Dr. Frank Gilfeather, UNM

Working Group V *- Special Topics****:*** *Test and Evaluation****:***
Session A-V Agenda

- Warning, the Critical Element to Mitigate the Effects of a CBRN Attack, Dr. Alan Avidan MadahCom, Inc.
- Sensor Placement Optimization, Mr. Keith Gardner, Northrop Grumman IT

BREAKOUT SESSION B
Working Group I - *Dispersion Modeling and Sensor Data Fusion****:***
Session B-I Agenda

- Fusion of Sensor and Model Data, Dr. Deborah Fish, Mr. Oliver Lanning and Mr. Paul Thomas
- Chemical/Biological Source Characterization, Richard Fry, DTRA, R. Ian Sykes, L-3 Titan, Ronald Kolbe, NGIT
- Sensor Placement Optimization, Mr. Keith Gardner, Northrop Grumman IT
- Sensor Location & Optimization Tool Set: Presentation - Paper, Mr. Michael J. Smith, ITT Industries, Advanced Engineering & Sciences
- Hazard Prediction with Nowcasting, Jason Nachamkin and John Cook, Naval Research Laboratory, and Michael Frost, Daniel Martinez, and Gary Sprung Computer Sciences Corporation
- Tracking Atmospheric Plumes Using Stand-off Sensor Data, Robert C. Brown, David Dussault, and Richard C. Miake-Lye Aerodyne Research, Inc. Patrick Heimbach, Department of Oceanography, Massachusetts Institute of Technology

Working Group II - *Special Topics I****:***
Session B-II Agenda

- Chemical, Biological, Radiological, and Nuclear (CBRN) and Medical Communities of Interest (COI) Information Sharing, Mr. Doug Hardy, JPM IS SSA Manager
- Providing Capabilities-Based Analytic Support In Dynamic Operational Environments, Mr. Mark Neff, Mr. Greg Wells and Mr. E. Mark Chicoine, Booze / Allen / Hamilton
- Development and Implementation of a Model for Predicting the Aerosolization of Agents in a Stack, Teri J. Robertson, Douglas S. Burns, Jeffrey J. Piotrowski, Dustin B. Phelps, Veeradej Chynwat and Eileen P. Corelli, ENSCO, Inc.
- Contamination Avoidance at Seaports of Debarkation: Presentation - Paper, Mr. Donald W. Macfarlane, David H. Drummond and William J. Ginley, NBC Battlefield Management Team, Edgewood Chemical Biological Center
- Advances in Biotechnology and the Biosciences for Warfighter Performance and Protection, Dr. Larry Regens, University of Oklahoma Health Sciences Center

Working Group III - *Battlespace Management****:***
Session B-III Agenda

- A Bayesian Approach for Assessing Confidence in a Biological Warfare (BW) Detection Event, Mr. Patrick L. Berry, U.S. Army Edgewood CB Center
- A New Bio IMS for Simultaneous Detection of CWAs and Biomaterials , Dr. Jürgen Leonhardt Flight Services, Inc
- Chem-Bio Protection Without Chem-Bio Sensors: Low Cost, Dual Use, Alternative Sensor and Information Architectures, Mr. Steven S. Streetman, ENSCO, Inc.

Working Group IV - *Decision Making and Support****:***
Session B-IV Agenda

- The Chemical and Biological Defense Information Analysis Center (CBIAC), a Knowledge Management Source for Authoritative Information, Donald McGonigle, KM Program Manager
- Flatland Visualization of A Decision Support Tool Architecture, Mr. Thomas Preston Caudell, Department of ECE, University of New Mexico
- Scenarios with the CBRN Data Model, Stephen Helmreich, Computing Research Laboratory, NMSU and Sundara Vadlamudi and Markus Binder, Monterey

- Institute of International Studies
- Machine Intelligence in Decision-making (MInD) Automated Generation of CB Attack Engagement Scenario Variants, Nadipuram R. Prasad, Arjun S. Rangamani, Timothy J. Ross, M. M. Reda Taha, Frank Gilfeather
- Methods for Understanding Human Interface Requirements for Decision Support Tools, Bill Ogden, Jim Cowie, and Chris Fields, New Mexico State University
- Allocation of Resources in CB Defense: Optimization and Ranking, J. Cowie, H. Dang, B. Li, Hung T. Nguyen, NMSU and F. Gilfeather, UNM

Working Group V** - Special Topics**:** Test and Evaluation**:
Session B-V Agenda

- Test and Evaluation (T&E) Thrust Area Overview, Eric Lowenstein, T&E Manager, Modeling & Simulation / Battlespace
- Reliable Discrimination of High Explosive and Chemical / Biological Artillery Using Acoustic Sensors, Myron E. Hohil, Sachi Desai, and Amir Morcos, US Army RDECOM-ARDEC
- Infrared Scene Simulation for Chemical Standoff Detection System Evaluation, Peter Mantica, Chris Lietzke, and Jer Zimmermann, ITT Industries, Advanced Engineering and Sciences Division and Fran D'Amico, Edgewood Chemical Biological Center ARDEC
- Neutrotest - A Neutron Based Nondestructive Device for Explosive Detection, Dr. Jürgen Leonhardt
- Dynamic Multi Sensor Management System, Mr. Thomas Sanderson and Mr. Fred Yacoby
- A Bayesian Approach for Assessing Confidence in a Biological Warfare (BW) Detection Event, Mr. Patrick L. Berry, U.S. Army Edgewood CB Center

Thursday, 28 October 2005

BREAKOUT SESSION C
Working Group I** - Dispersion Modeling and Sensor Data Fusion**:
Session C-I Agenda

- An Atmospheric Chemistry Module for Modeling Toxic Industrial Chemicals (TICs) in SCIPUFF, Douglas S Burns, Veeradej Chynwat, Jeffrey J Piotrowski, Kia Tavares, and Floyd Wiseman, ENSCO, Inc.
- Chemical and Biological Hazard Environmental Prediction, Mr. Michael Armistead, NSWC, Dahlgren Division (NSWCDD)
- Development and Implementation of a Model for Predicting the Aerosolization of Agents in a Stack, Teri J. Robertson, Douglas S. Burns, Jeffrey J. Piotrowski, Dustin B. Phelps, Veeradej Chynwat and Eileen P. Corelli, ENSCO, Inc.
- Nowcasting and Urban Interactive Modeling Using Robotic and Remotely Sensed Data, James Cogan, Robert Dumais, and Yansen Wang, Meteorological Modeling Branch, Battlefield Environment Division, Computational & Information Sciences Directorate, U.S. Army Research Laboratory

- MSG Ground *(Video)*
- Quasi Steady Run *(Video)*
- Meandering Wind *(Video)*
- Measurement of Coastal & Littoral Toxic Material Tracer Dispersion, Dr. Robert E. Marshall
- Coupled Air -- Sea Modeling for Improved Coastal Dispersion Prediction, Julie Pullen, Marine Meteorology Division, Naval Research Laboratory

Working Group II** - Current Ops Effect S & T Projects**:
Session C-II Agenda

- JOEF Prototype Development Activities, Dr. Tom Stark, Cubic Defense Applications
- Next Generation Modeling of Operational Effects and CHEMRAT and Updating Air Force Manuals 10-2602 & 10-2517, Maj William Greer, AFRL HEPC
- Impact Assessment Tool, Dr. Ben Swindlehurst, Dstl, Mr. Darrell Lochtefeld, Anteon Corporation and Mr. Andrew Solman, Dstl
    - AOCA *(Video)*
    - Trace Double *(Video)*

- CB System Military Worth Assessment Toolkit, Chris Gaughan, ECBC, Dennis Jones, ITT, Derrick Briscoe, ITT, and Jim Sunkes, ITT
- Predictive Models for Chem-Bio Human Response, Casualty Human Response, Estimation and Patient Loads, Gene McClellan, Karen Cheng, and Jason Rodriguez

Working Group III** - Battlespace Management**:
Session C-III Agenda

- "Net-Ready" CBRN Sensors – A Way Forward…, Chuck Datte, Ritesh Patel and David W. Godso
- Wirelessly Enabling Legacy Sensor Systems for Rapid Deployment and Monitoring, Mr. Joshua Pressnell, RTI
- Dynamic Multi Sensor Management System, Mr. Thomas Sanderson and Mr. Fred Yacoby

Working Group IV** - Decision Making and Support**:
Session C-IV Agenda

- Monotone Measure Theory as a Method for Combining Evidence in Threat Scenarios, Greg M. Chavez, Timothy J. Ross, Mahmoud Reda Taha, Ram Prasad
- Algorithmically Generated Music Enhances VR Decision Support Tool, Dr. Panaiotis, Department of Music & Department of Electrical and Computer Engineering, The University of New Mexico
- Exploring Optimization Methodologies for Systematic Identification of Optimal Defense Measures for Mitigating CB Attacks, Roshan Rammohan, Molly McCuskey, Mahmoud Reda Taha, Tim Ross and Frank Gilfeather, University of New Mexico and Ram Prasad, New Mexico State University
- DTRA -Modeling and Simulation/Battlespace - BO05MSB070: Multivariate Decision Support Tool for CB Defense, Dr. Frank Gilfeather, UNM

Working Group V** - Special Topics**:** Test and Evaluation**:
Session C-V Agenda

- CBRN Data Model CBRN Data Model Implementation Approach, Mr. William Snee, MSIAC/ Alion Science and Technology and Professor Tom Johnson, Naval Postgraduate School
- Chemical Homeland Security System: C-HoSS, Mr. Kevin Kennedy, Chemical Compliance Systems, Inc.

BREAKOUT SESSION D
Working Group I - *Dispersion Modeling and Sensor Data Fusion****:***
Session D-I Agenda

- Release and Atmospheric Dispersal of Liquid Agents, Theo Theofanous (PI), University of California and Rich Couch, Program Manager, Lawrence Livermore National Laboratory
- Modeling and Simulation to Support Virtual Chemical Hazard Environments, Dr. Jeffery D. Peterson, Dr. James A. Kleimeyer and Dr. Richard J. Green, West Desert Test Center, Dugway Proving Ground
- Proposed Translation of Joint Effects Model (JEM) Accuracy Requirement Into a Measurable Acceptability Criterion, Steve Warner, Nathan Platt and James F. Heagy, Institute for Defense Analyses

Working Group II - *Operations Effects Modeling****:***
Session D-II Agenda

- Combined Defense, Mr. Keith Gardner, Northrop Grumman IT
- Health Effects Decision Support Tool for Civilian CB Air and Water Attack Scenarios, Dr. Shanna Collie, Toxicologist and Project Manager, Tetra Tech
- Reality Simulation to Train for Prevention, Deterrence, Response, and Recovery for Chem Bio Events, Mr. Scott Milburn, Reality Response
  - SVS at Fort Benning *(Video)*
  - Dismounted Simulation *(Video)*

Monday, October 24

3:00 PM-5:00 PM	Registration

Tuesday, October 25

7:30AM -8:30AM	Late Registration and Continental Breakfast
8:30AM-8:45AM	Welcome and Introduction
8:45AM-9:15AM	***Keynote* – BG Stephen V. Reeves, USA** Joint Program Executive Officer for Chemical Biological Defense
9:15AM-9:45AM	***Keynote* – Dr. Charles R. Gallaway** Director Chem Bio Defense Science and Technology Directorate Defense Threat Reduction Agency
9:45AM-10:15AM	***Keynote* – COL Don Bailey, USA** Deputy Director, Joint Requirements Office for Chemical Biological, Radiological and Nuclear Defense
10:15AM-10:45AM	**Break**
10:45AM-11:10AM	Technology Transitioning Overview
11:10AM-11:35AM	Joint Project Manager Information Systems Program Overview
11:35AM-1:00PM	**Lunch**
1:00PM-1:30PM	Joint Effects Model Program Overview
1:30PM-2:00PM	Joint Operational Effects Federation Program Overview
2:00PM-2:30PM	Joint Warning and Reporting Network Program Overview
2:30PM-3:00PM	Joint Project Manager Information Systems Integration Overview
3:00PM-3:30PM	**Break** *& Joint Project Manager Information Systems Demonstration*
3:30PM-4:00PM	Joint Science and Technology Office Program Overview
4:00PM-4:30PM	Environmental Hazard Prediction Thrust Area Overview
4:30PM-5:00PM	Operations Effects Thrust Area Overview
5:00PM-5:30PM	Battlespace Management Thrust Area Overview
5:30PM	Adjourn for the day
5:30PM-6:30PM	**Reception** *& Joint Project Manager Information Systems Demonstration*

Wednesday, October 26

8:00AM-8:30AM	Registration and Continental Breakfast
8:30AM-8:35AM	Admin Remarks
8:35AM-9:10AM	Agent Fate Program Overview
9:10AM-9:30AM	Decision Support Program Overview
9:30AM-9:50AM	Research Development and Engineering Command (RDECOM) Overview
9:50AM-10:20AM	**Break** *& Joint Project Manager Information Systems Demonstration*
10:20AM-12:00PM	Breakout Session A

Working Group I - Dispersion Modeling and Sensor Data Fusion
Session Chair: John Pace

10:20 AM – 10:50 AM	John Pace	Overview of Hazard Prediction Modeling Program
10:55 AM – 11:25 AM	Paul Thomas	Source Term Estimation Module (STEM)
11:30 AM – 12:00 PM	Ian Griffiths	STEM demo

Working Group II – Chemical Agent Persistence and Prediction Modeling
Session Chair: Mark Fagan

10:20 AM – 10:50 AM	Dr. Arianus R. Hin	Agent Fate Predictive Model Methodology
10:55 AM – 11:25 AM	Dr. Homayun	Agent Fate 1st Principles Modeling
11:30 AM – 12:00 PM	Dr. Evans	Quantum Chem Theoretical Modeling

Working Group III - Battlespace Management
Session Chair: Bill Ginley

10:20 AM – 10:50 AM	Mr. Bill Ginley	Shared COP
10:55 AM – 11:25 AM	Mr. James Reilly	Next Generation CB Battle Management System
11:30 AM – 12:00 PM	Mr. James Reilly	Next Generation CB Battle Management System

Working Group IV - Decision Making and Support
Session Chair: Scott Cahoon

10:20 AM – 10:50 AM	Dr. Jeffrey Grotte	Decision Support Analytical Framework
10:55 AM – 11:25 AM	Mr. Michael Kierzewski, Mr. King	Virtual Prototyping Feasibility/Benefit and CB Common Knowledge Base
11:30 AM – 12:00 PM	Dr. Frank Gilfeather	Chemical and Biological Defense Multivariate Decision Support Tool

Working Group V - Special Topics: Test and Evaluation
Session Chair: Eric Lowenstein

10:20 AM – 10:50 AM	Dr. William Brence	A Quantitative Tool for the Identification, Correlation, and Selection of Chemical Agent Simulants for OT&E; Implications for and Applications to Current and Future Programs
10:55 AM – 11:25 AM	Avidan	MNS/CBRN System Integration

11:30 AM – 12:00 PM	TBD	TBD

12:00PM-1:00PM **Lunch** (On Own)
1:00PM-3:30/5:00PM Breakout Session B

Working Group I - Dispersion Modeling and Sensor Data Fusion
Session Chair: John Pace

1:00 PM – 1:30 PM	Dr. Deborah Fish	Fusion of CB Data and Model Output
1:30 PM – 2:00 PM	Mr. Rick Fry	Chemical/Biological Source Characterization
2:00 PM – 2:30 PM	Mr. Keith Gardner	Optimizing Sensor Placement for CB Defense
2:30 PM – 3:00 PM	Mr. Mike Smith	Sensor Location Optimization Tool Set
3:00 PM – 3:30 PM	Jason Nachamkin	Hazard Prediction with Nowcasting

Working Group II – Special Topics I
Session Chair: Mark Fagan

1:00 PM – 1:30 PM	Mr. Doug Hardy	The Need for CBRN and Medical COI Interoperability and the Proposed Way Forward
1:30 PM – 2:00 PM	Mr. Mark Neff	Providing Capabilities-Based Analysis in Dynamic Operational Environments: Leveraging Integrated Architecture and Use Cases to Define and Deliver Rapid Capabilities
2:00 PM – 2:30 PM	Mr. David Gregory	Chemical and Biological Warfare Modeling Library (CBWLIB)
2:30 PM – 3:00 PM	Mr. Donald McFarlane	Contamination Avoidance at Seaports of Debarkation (CASPOD) ACTD: A Study in the Importance of Early User Involvement During User Interface and System Capabilities Development
3:00 PM – 3:30 PM	Dr. James L. Regens	Advances in Biotechnology and the Biosciences for Warfighter Performance and Protection

Working Group III - Battlespace Management
Session Chair: Bill Ginley

1:00 PM – 1:30 PM	Mr. Patrick Berry	A Bayesian Approach for Assessing Confidence in a Biological Warfare (BW) Detection Event
1:30 PM – 2:00 PM	Mr. Thomas Sanderson	Hyperspectral Mid-Range Toxic Gas Detection System
2:00 PM – 2:30 PM	Dr. Juergen Leonhardt	A New BIO IMS for Simultaneous Detection of CWA Material
2:30 PM – 3:00 PM	Mr. Thomas Sanderson	Multi-Sensor Battlespace Management Architecture
3:30 PM – 4:00 PM	Mr. Steven Streetman	Chem-Bio Protection Without Chem-Bio Sensors: Low Cost, Dual Use Alternative Sensor and Information Architectures

Working Group IV - Decision Making and Support
Session Chair: Scott Cahoon

1:00 PM – 1:30 PM	Mr. Donald McGonigle	The Chemical and Biological Defense Information Analysis Center (CBIAC), a Knowledge Management Source for Authoritative Information
1:30 PM – 2:00 PM	Dr. Rafael Alonso	A Chem-Bio Information System for Rapid Knowledge Acquisition to Support Bio-weapons Countermeasures
2:00 PM – 2:30 PM	Caudell	Flatland Virtual Data Decision Support Tool
2:30 PM – 3:00 PM	Dr. Steve Helmreich	Coordinating CB engagement scenarios with the CBRN
3:00 PM – 3:30 PM	**BREAK**	
3:30 PM – 4:00 PM	Prasad	Data Model Machine Intelligence in Decision-making (MInD) Automated Generation of *CB* Attack Engagement Scenario Variants
4:00 PM – 4:30 PM	Dr. Bill Ogden	Methods for Understanding Human Interface Requirements for Decision Support Tools
4:30 PM – 5:00 PM	Dr. Hung Nguyen	Allocations of Resources in CB Defense: Optimization and Ranking

Working Group V - Special Topics: Test and Evaluation
Session Chair: Eric Lowenstein

1:00 PM – 1:30 PM	Dr. Timothy Shelly	A Distributed Processing Sensor Network for Detect-To-Warn Capability
1:30 PM – 2:00 PM	Dr. Jonathan Davis	Development of Plague Outbreak Decision Tool
2:00 PM – 2:30 PM	Dr. Myron Hohil	Reliable Discrimination of High Explosive and Chemical/Biological Artillery Using Acoustic Sensors
2:30 PM – 3:00 PM	TBD	TBD
3:00 PM – 3:30 PM	**BREAK**	
3:30 PM – 4:00 PM	Dr. Peter Mantica	Infrared Scene Simulation for Chemical Standoff Detection System Evaluation
4:00 PM – 4:30 PM	Dr. Juergen Leonhardt	Neutro Test – A Neutron Based Non-Destructive Device for Finding Hidden Explosives
3:30 PM – 4:00 PM	Dr. Peter Mantica	Infrared Scene Simulation for Chemical Standoff Detection System Evaluation

5:00 PM Adjourn for the day

5:30 PM Social Hour

6:30 PM-8:00 PM CBIS Annual Banquet
Guest Speaker Gary Yamamoto “Restore the Passion: For Work and For Life!”

Thursday, October 27

8:00AM-8:30AM **Continental Breakfast**

8:30AM-8:35AM Admin Remarks

8:35AM-10:00AM Breakout Session C

Working Group I - Dispersion Modeling and Sensor Data Fusion
Session Chair: John Pace

8:35 AM – 9:00 AM	Dr. Douglas Burns	An Atmospheric Chemistry Module for Modeling Toxic Industrial Chemicals
9:00 AM – 9:30 AM	Mr. Mike Armistead	Chemical and Biological Hazard Environmental Prediction
9:30 AM – 10:00 PM	Ms. Teri Robertson	Development of a Model for Predicting the Aerosolization of Agents in a Stack

Working Group II – Current Ops Effect S & T Projects
Session Chair: Mark Fagan

8:35 AM – 9:00 AM	Dr. Tom Stark	JOEF Prototype Development
9:00 AM – 9:30 AM	Maj William Greer	Next Generation model Development
9:30 AM – 10:00 PM	Darrell Lochtefeld	Impact Assessment Tool

Working Group III - Battlespace Management
Session Chair: Bill Ginley

8:35 AM – 9:00 AM	Mr. Javad Sedehi	Battlespace Management Field Trip
9:00 AM – 9:30 AM	Mr. Jack Berndt	Engineering NBC-RPM
9:30 AM – 10:00 PM	Mr. David Godso	Net-Ready CBRN Sensors -- The Way Ahead

Working Group IV - Decision Making and Support
Session Chair: Scott Cahoon

8:35 AM – 9:00 AM	Mr. Gregory Chavez	Monotone Measure Theory as a Method for Combining Evidence in Threat Engagements
9:00 AM – 9:30 AM	Dr. Panaiotis	Algorithmically Generated Music Enhances VR Decision Support Tool
9:30 AM – 10:00 PM	Dr. Roshan Rammohan	Exploring Optimization Methodologies for Systematic Identification of Optimal Defense Measures For Mitigating *CB* Attacks

Working Group V - Special Topics: Test and Evaluation
Session Chair: Eric Lowenstein

8:35 AM – 9:00 AM	Mr. Peter Mantica	Active Standoff Chemical Detection Model for System Studies
9:00 AM – 9:30 AM	Mr. William Snee	Phased Data Model Implementation Approach
9:30 AM – 10:00 PM	Dr. George Thompson	Chemical Homeland Security System (C-HoSS)

10:00AM-10:30AM **Break** *& Joint Project Manager Information Systems Demonstration (Last Chance to view Demo)*
10:30AM-12:00PM Breakout Session C Continued

Working Group I - Dispersion Modeling and Sensor Data Fusion
Session Chair: John Pace

10:30 AM – 11:00 AM	Julie Pullen	Coupled Air-Sea Modeling for Improved Coastal Urban Dispersion Prediction
11:00 AM – 11:30 AM	Rob Marshall	Measurement of Coastal & Littoral Toxic Material Tracer Dispersion
11:30 AM – 12:00 PM	John Hannan	Intercomparison of Four Rockle-Based Urban Dispersion Models

Working Group II – Special Topics II
Session Chair: Mark Fagan

10:30 AM – 11:00 AM	Maj Greer	CHEMRAT and AFMAN 10-2602 Persistence Modeling
11:00 AM – 11:30 AM	Tim Gaughan	CB System Military Worth Assessment Toolkit
11:30 AM – 12:00 PM	Dr. Gene McClellan	Predictive Models for Chem-Bio Human Response, Casualty Estimation and Patient Loads

Working Group III - Battlespace Management
Session Chair: Bill Ginley

10:30 AM – 11:00 AM	Mr. Joshua Pressnell	Wirelessly Enabling Legacy Sensor Systems for Rapid Deployment and Monitoring
11:00 AM – 11:30 AM	Mr. Thomas Sanderson	Performance Quality Monitoring Architecture for Sensor Networks
11:30 AM – 12:00 PM	TBD	

Working Group IV - Decision Making and Support
Session Chair: Scott Cahoon

10:30 AM – 12:00 PM	Dr. Frank Gilfeather	Multivariate Decision Support Tool Set-up

Working Group V - Special Topics: Test and Evaluation
Session Chair: Eric Lowenstein

10:30 AM – 11:00 AM		Program Decision Issues
11:00 AM – 11:30 AM		Program Decision Issues
11:30 AM – 12:00 PM		Program Decision Issues

12:00PM-1:30PM **Lunch (On your own)**

1:30PM-3:30PM Breakout Session D (and concurrent Executive Session)

Working Group I - Dispersion Modeling and Sensor Data Fusion
Session Chair: John Pace

1:30 PM – 2:00 PM	Theo Theofanous	Release and Atmospheric Dispersal of Liquid Agents
2:00 PM – 2:30 PM	Dr. Jeffrey Peterson	Modeling and Simulation to Support Virtual Chemical Hazard Environments
2:30 PM – 3:00 PM	Dr. Steve Warner	Translation of JEM Accuracy Requirement into a Measurable Acceptability Criterion

Working Group II - Operations Effects Modeling
Session Chair: Mark Fagan

1:30 PM – 2:00 PM	Mr. Keith Gardner	Combined Defense Model
2:00 PM – 2:30 PM	Dr. Shanna Collie	Health Effects Decision Support Tool for Civilian CB Air and Water Attack Squadron
2:30 PM – 3:00 PM	Mr. Scott Milburn	Employing Military Virtual Reality Simulation Technology to Train for Prevention, Deterrence, Response, and Recovery for Chem Bio Events

Working Group III - Battlespace Management
Session Chair: Bill Ginley

1:30 PM – 2:00 PM		Program Decision Issues
2:00 PM – 2:30 PM		Program Decision Issues
2:30 PM – 3:00 PM		Program Decision Issues

Working Group IV - Decision Making and Support
Session Chair: Scott Cahoon

1:30 PM – 3:30 PM	Cahoon, Gilfeather	Presentation of Chemical and Biological Defense Multivariate Decision Support Tool to Dr. Charles Gallaway

Working Group V - Special Topics: Program Decision Issues
Session Chair: Eric Lowenstein

1:30 PM – 3:30 PM		Program Decision Issues
2:00 PM – 2:30 PM		Program Decision Issues
2:30 PM – 3:00 PM		Program Decision Issues

3:30PM **Conference Adjourns**

***********Following for JPM IS personnel, JSTO personnel and Session Chairs*********************

4:00PM-5:00PM Hotwash and Summary from Working Group Chairs

5:00PM Adjourn for the day

Friday, October 28

8:00AM-8:30AM **Continental Breakfast**

8:30AM-10:00AM Executive Session

10:00AM Conference Adjourns

Chemical and Biological Hazard Environmental Prediction

October 27, 2005

Michael Armistead
NSWC - Dahlgren Division (NSWCDD)

Outline

- Description of Effort
- Task 1: MESO
  - MESO Background
  - MESO FY05 Objectives
  - MESO Achievements
- Task 2: CBW-CFX/CBW Libraries (CBWLIB)
  - CBW-CFX Background
  - Work Transition from CBW-CFX to CBWLIB
  - CBWLIB FY05 Objectives
  - CBWLIB Achievements
- FY06 Objectives
- Questions?

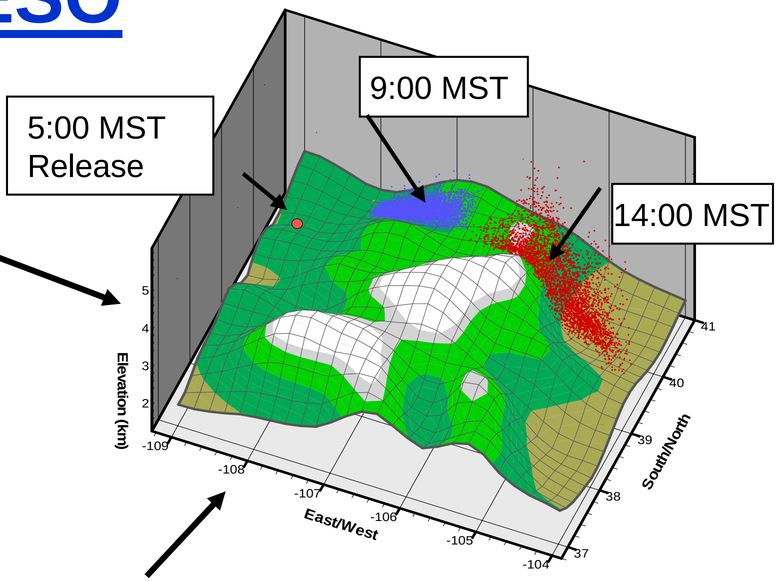
Description of Effort

- **Improve the state-of-the-art of CB hazard prediction modeling beyond Gaussian puff by:**
  - **Developing a Lagrangian particle transport model for rapid analysis of atmospheric releases [MESO]**
  - **Developing CB libraries to support a computational fluid dynamics based model for high resolution analysis around buildings and ships [CBW-CFX]**
- **Address the physical and CB processes affecting CB agents released**
- **Transition physics into libraries that will be tested in CBW-CFX**
- **Provide MESO and the libraries for transition to the Joint Effects Model (JEM) and the Joint Operation Effects Federation (JOEF)**

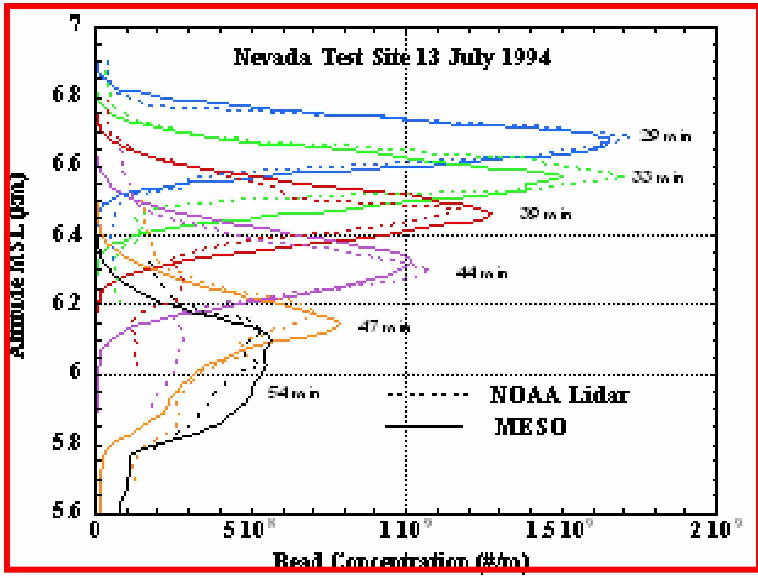
Develop hazard prediction models and CB libraries for transition to JEM and JOEF.

Background – MESO

MESO prediction showing transport of hazard across complex terrain



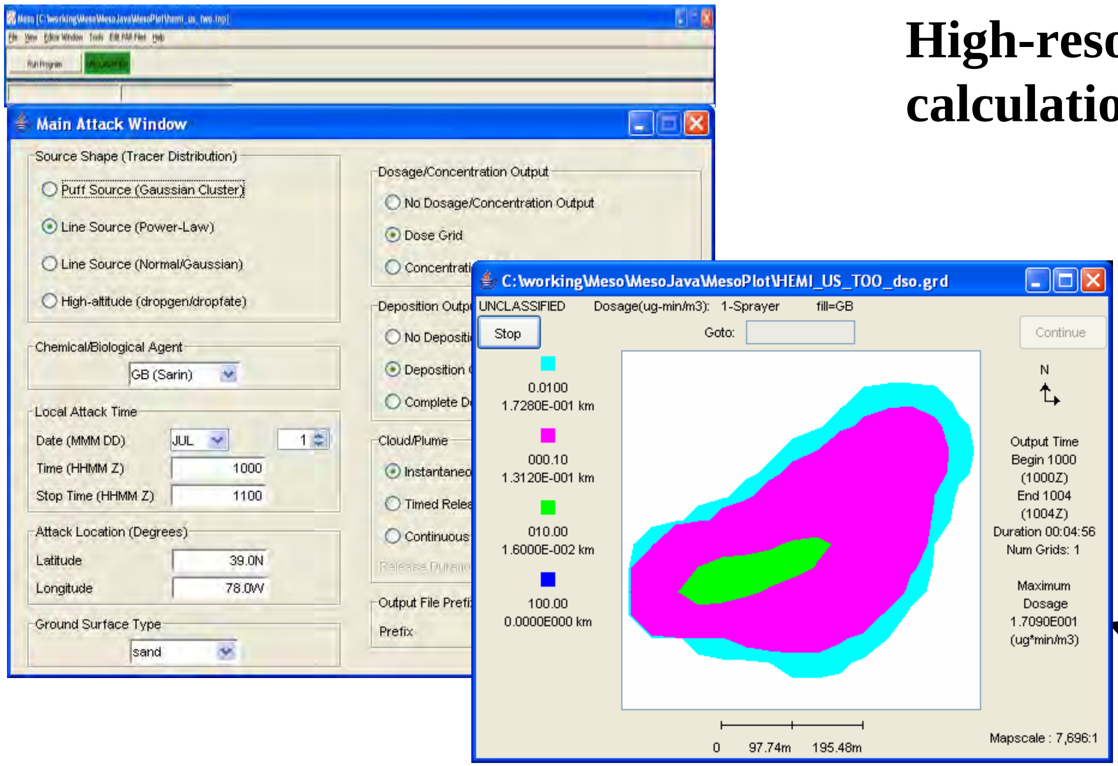
MESO Simulation With Meteorology provided by COAMPS (Coupled Ocean/Atmosphere Mesoscale Prediction System)



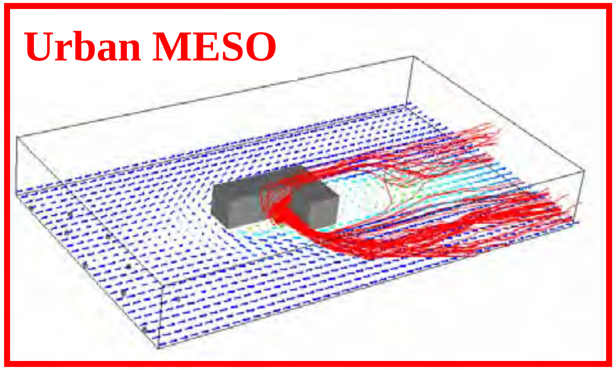
MESO validation using Crystal Mist data shows excellent performance at high elevations (up to 7 km)

MESO incorporates advanced meteorological and agent physics into a Lagrangian particle transport model to provide higher resolution simulations.

Background – MESO (cont.)



High-resolution dispersion calculation around buildings



More user-friendly interface

Past improvements to MESO (ease of use, improved atmospheric and CB physics, run-time enhancements, etc.) have been leveraged toward the urban environment.

MESO: FY05 Objectives

- **Verification**
  - Complexity Analysis
  - Test of MESO GUI Inputs
  - Verification of Methodology in Code
  - Test of Subroutines
- **Validation**
  - Field Trial Comparisons
- **Documentation**
  - SDD
  - SUM
  - V&V Report

MESO needs V&V and documentation to support transition to JEM.

MESO Verification of Code

- **Verification of Methodology in Code**
  - Developers verification of code complete
  - Work resulted in corrections to: BndryLayerUpdate3D, ClearAirTurb, VertDiffus, and DepositionVelocity
  - NSWCDD reviewing and spot-checking equations
- **Test of Subroutines**
  - Exercise every function
  - Qualitatively check each version
  - Test design complete

The MESO methodology was verified during the SDD development and is being independently checked. Test cases are being designed to exercise every function for initial check of new modifications.

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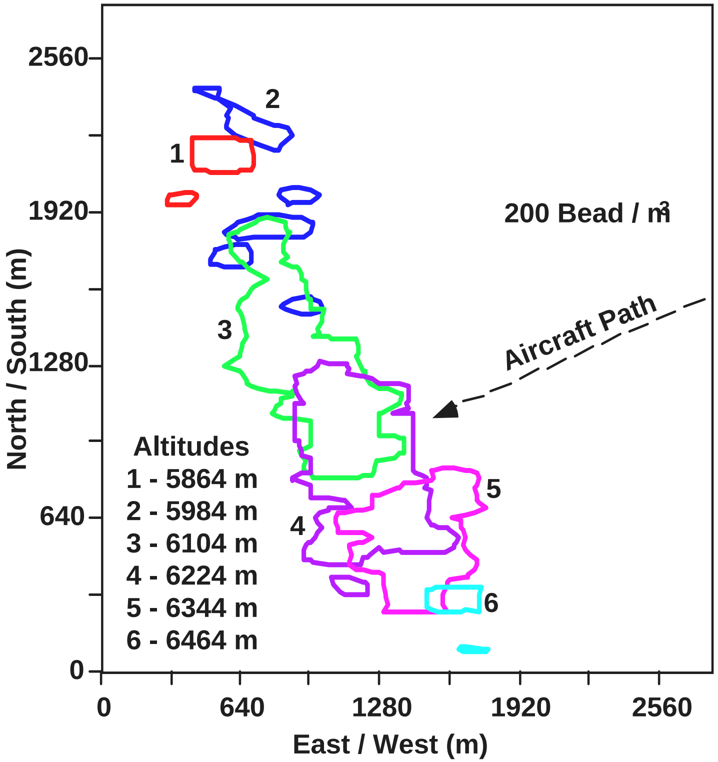
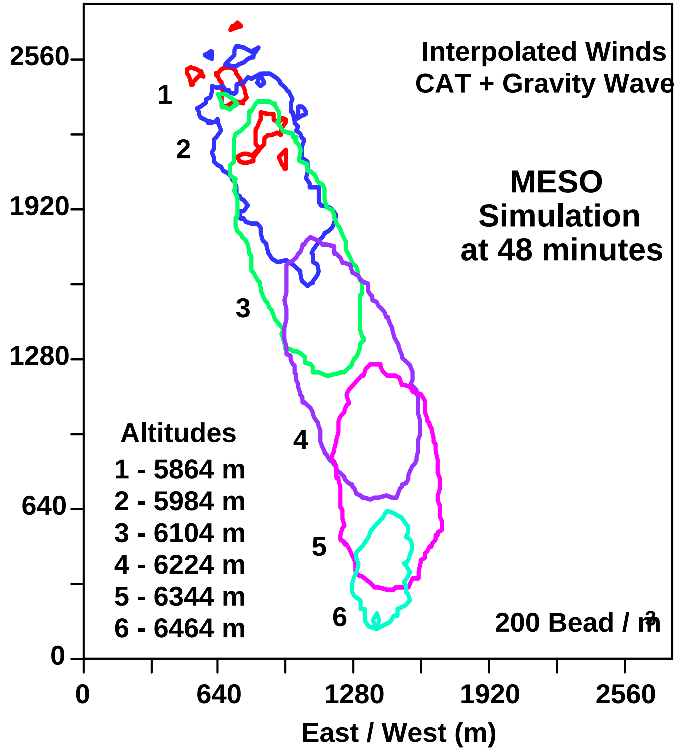
Chemical and Biological Hazard Environmental Prediction

MESO Validation

NOAA Lidar



MESO Simulation



A subset of cases run during the VLSTRACK validation is being used to validate MESO in a three-way comparison.

MESO Documentation

- **Software User's Manual**
  - Needs minor updates for new version
  - In review

- **Software Design Description**
  - 900 page document
  - In review

- **Verification and Validation Report**
  - Forward sections complete
  - Field trial sections in progress

The V&V reports are awaiting completion of the V&V tasks.

MESO Status

- **Verification**
  - Complexity Analysis — Complete
  - Test of MESO inputs — 90%
  - Verification of Methodology in Code — 85%
  - Test of Subroutines — 90%

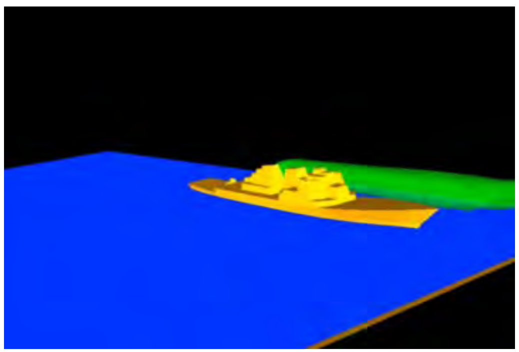
- **Validation**
  - Field Trial Comparisons — 70%

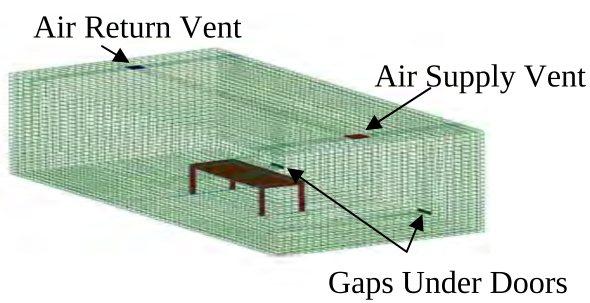
- **Documentation**
  - SDD — In review
  - SUM — In review
  - V&V Report — 45%

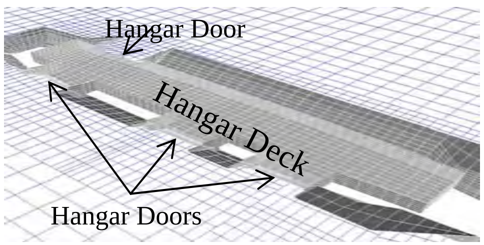
V&V progressing, but at a slower pace than expected.

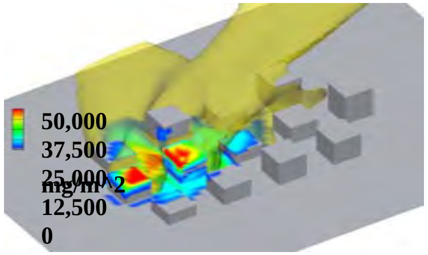
Background - CBW-CFX

- **An integrated system of COTS and Government Computational Fluid Dynamics (CFD) technology for CBW Hazard Prediction**









- **Models transport of vapor and particles entrained in the air flow**
- **Models droplet evaporation, surface deposition, and weathering effects**
- **Implement additional CBW physics via user-defined subroutines**

CBW-CFX provides high-fidelity CFD simulation over and through moving or stationary 3D structures such as ships and buildings.

Work Transition: CBW-CFX/CBWLIB

- **The Past:**
  - Under CB.55, NSWCDD advanced the fidelity of hazard predictions through the development of CB capabilities within CBW-CFX

- **Current and Future:**
  - NSWCDD is now developing these capabilities to be useable as compiled generic library functions
  - Updated and extendable library framework
  - Easily interfaced and called from any general CFD code
  - Modularize legacy code with minimal rewriting
  - The libraries will be validated vs. experimental data (incl. field trials)
  - Dynamic library approach will enhance transition to JEM through dynamically linked library (.dll) or shared object library (.so)

CB capabilities developed, tested, and embedded in existing codes are being converted to libraries that will be easier to transition to JEM.

CBWLIB: FY05 Objectives

- Develop CB-hazard-specific physics models into generic, standalone library functions with clean interfaces for ease of reuse and incorporation into evolving CFD-based transport and dispersion simulation tools
- V&V of libraries to ensure proper functionality and accuracy
- Document libraries and their functions to ensure ease of use and integration with candidate simulation codes
- Execute configuration management practices to ensure reliability

FY05 shifts toward library development to provide better mechanism for transition.

CBWLIB: Achievements

- Developed a systematic approach to library development
- Implemented a robust configuration management process
  - Stress tested with 5 developers simultaneously working on the same 1500 line module
- Systematic peer review of legacy source code
- Created documentation standard and documented the existing CBW-CFX code
- Ported legacy capabilities into CBWLIB

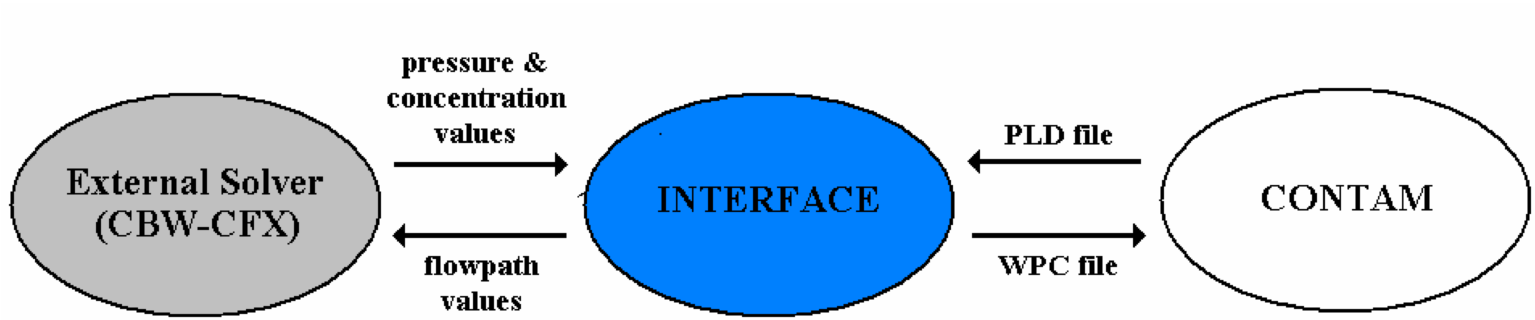
A systematic approach is being used to port legacy capabilities into CBWLIB.

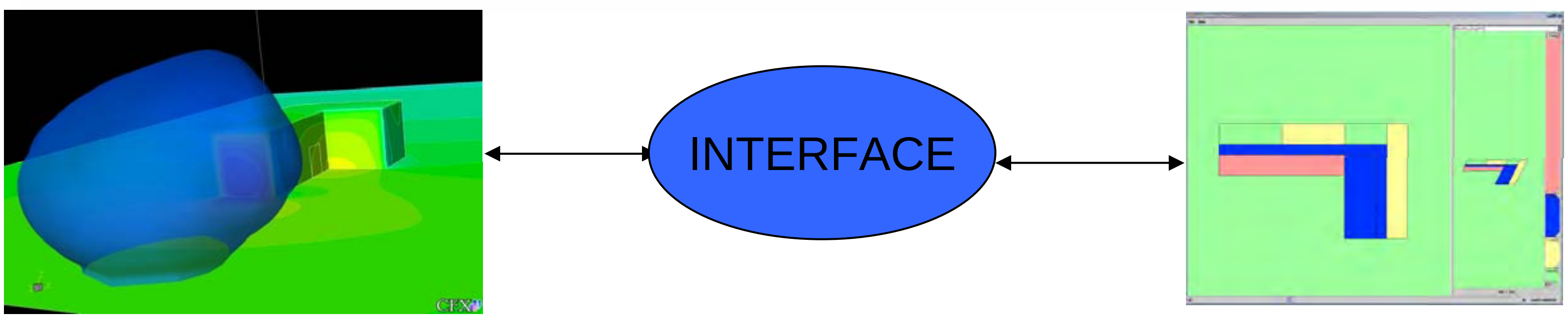
CBWLIB: Contributors

- Leverages multiple projects
  - DARPA Immune Building
  - JEM
  - Agent Fate
  - MESO
- International collaboration
  - Missile Intercept (NL)
  - Explicit Uncertainty (UK)

CBWLIB has contributors and users among many DoD projects and the CB community.

CONTAM Interface





A new technology developed within the CBWLIB framework and utilized by several outside projects.

FY06 Objectives

- **MESO Model Standardization Effort (atmospheric and urban versions)**
  - MESO Atmospheric and Urban Model Integration
  - MESO GUI and document standardization
- **CFD Library Development Effort**
  - CBWLIB Development
    - Continue CBW-CFX Methods Integration
    - Integrate JEM High Altitude Intercept Library
    - Integrate Relevant ADVEDS Modules
    - Integrate Surface Evaporation Functionality
  - CFD Model Comparison
  - Module Validation vs. Legacy Benchmark
    - CBW-CFX vs. CFX (with library) Verification
    - Sample FLUENT (with library) Runs vs. Benchmark
  - Library Documentation

FY06 plans are to merge and standardize the two MESO models and complete CFD Library development for transition to JEM.

Currently Two Slightly Different MESO Models

- **Atmospheric MESO - NSWCDD has been developing the MESO Lagrangian model for atmospheric releases**
- **Urban MESO - Urban capabilities were added to NSWCDD developed model through leveraging by other DoD organization**
- **FY06 will standardize the models**
  - **Common call**
  - **Code reuse**
  - **Documentation**
  - **GUI**

Work under CB55 was leveraged and configuration management is necessary to control the final product.

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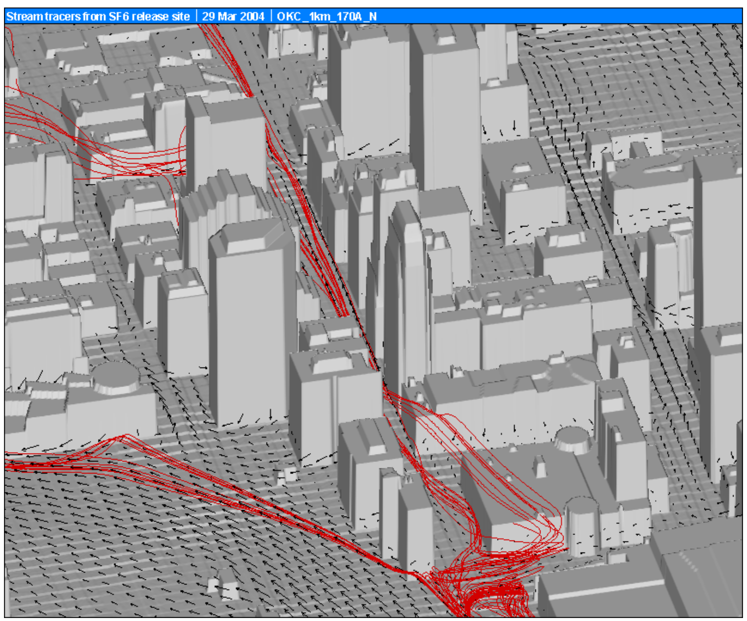
MESO/RUSTIC is a New Generation Model That Provides Accurate 3D Urban Hazard Definitions

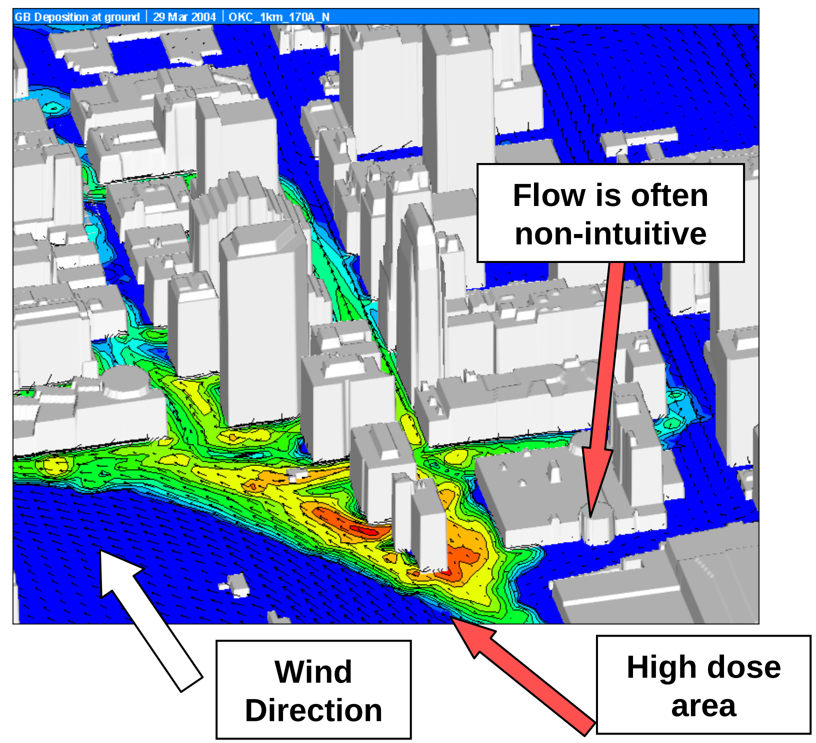
Two Steps for Urban CBR Hazard Definition with MESO/RUSTIC

1. **Compute turbulent "wind flow" with RUSTIC for urban scenarios.**
2. **Use MESO to compute contaminant dispersion with flow and turbulence predicted by RUSTIC.**



Downtown Oklahoma City July 2003

Approved for Public Release, Distribution Unlimited, DARPA (MESO/RUSTIC Case 2585)



Results from the leveraged MESO effort in an urban environment.

Questions?

Summary

The models being developed address a variety of challenges:

- **Wide range of scales (meters to many kilometers)**
  - **MESO developed for large open areas and CFD codes for urban and ships**
- **Wide variety of interacting processes involved and variety of operational environments that must be addressed**
  - **Models that include full CB physics**
- **Interaction between models for various purposes, domains**
  - **Libraries that help interface VLSTRACK to CBW-CFX and CBW-CFX to CONTAM**
- **Supporting databases (e.g., buildings) and enabling technologies (e.g., weather)**
  - **urban-MESO grid generator; MESO interface to COAMPS meteorological data**
- **Computation time vs. resolution**
  - **Speed enhancements to MESO; use of CFD codes for sensor placement, studies, or validation of other models**
- **V&V - verification reviews, data collection, validation studies**
  - **V&V of MESO and CBWLIB**

The model development addresses many challenges while advancing the state-of-the-art.

An Atmospheric Chemistry Module for Modeling Toxic Industrial Chemicals (TICs) in SCIPUFF

Douglas S Burns, Veeradej Chynwat, Jeffrey J Piotrowski, Kia Tavares, and Floyd Wiseman

ENSCO, Inc.

Science and Technology for Chem-Bio Information Systems (S&T CBIS)

October 28, 2005

BAA TYN 03-001
Atmospheric Chemistry Module for Toxic Industrial Chemicals

Tyndall AFB / DTRA

Michael Henley
AFRL/MLQ Tyndall AFB, FL

Martin Bagley
DTRA / TDOC Alexandria, VA

Outline

- **Project Goals**
- **Methodology**
  - Integration in SCIPUFF
  - Chemistry of 1-butene
  - Derivation of k_{eff}, X_{eff}
  - Parameter Space
- **Results**
  - Model output
    - Decay of TICs (1-Butene, Methylpropene)
    - Product Formation
- **Summary**

Project Goals

- **Develop initial atmospheric chemistry capability**
  - Develop Atmospheric Chemistry Algorithm
    - Algorithm MUST run rapidly.
    - Develop generic algorithm so that a detailed chemical kinetics approach is not required.
    - Algorithm must account for all (most) modeling scenarios (e.g., CC, T, ambient conditions).
    - Algorithm must be robust enough to account for diurnal changes to degradation rates.
    - Algorithm should account for the potential generation of intermediate toxic compounds.
  - Develop Chemical data for the Chemistry Algorithm
    - Review existing chemistry data for nine alkenes (and H_2S)
    - Develop mechanisms used to generate chemistry algorithm.
- **Couple Algorithm to SCIPUFF**
  - Work with Dr. Sykes to create interface with SCIPUFF
- **Launch Chemistry Module from HPAC**

Methodology: Minor Modification to SCIPUFF

SCIPUFF Dispersion

$$\text{———} = -$$

$$= \int$$

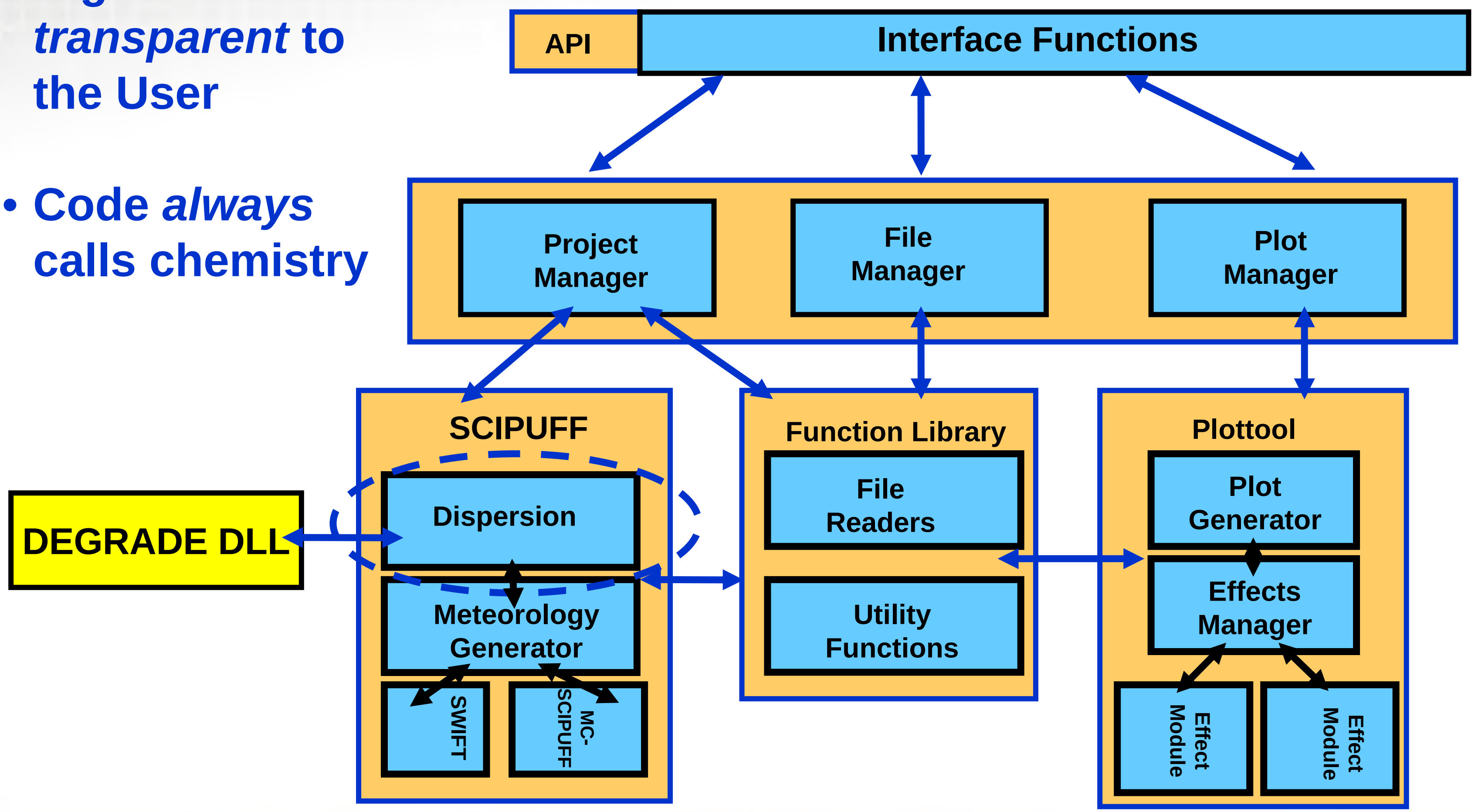
$$k_A = \max\left(k_A^{(\max)} \sin(\phi), k_A^{(\min)}\right)$$

$$k_A = k_{eff} = f(\phi, [amb], T, cc, humidity, etc.)$$

Method: Create Degrade Dynamic Link Library

Details in the Software Development Plan

- **Algorithm is *transparent* to the User**
- **Code *always* calls chemistry**



Methodology: Chemistry of 1-butene

Determine
ID Rxn's, E_A, k(T)
(w/ OH, NO_3, H_2O, O_3, etc.)

↓

Implement in Detailed Mechanism

↓

Run PBM as f(met parm's)

↓

Obtain $c_{TIC}(t)$ as f(met parm's)

→

Derive Empirical k_{eff} (met parm's)

→

Populate SCIPUFF data tables w/ k_{eff} for TICs

Methodology: Chemistry of 1-butene

$$CH_2{=}CHCH_2CH_3 + OH \longrightarrow 0.94\ C_2H_5CHO + \text{Other products}$$

$$CH_2{=}CHCH_2CH_3 + NO_3 \longrightarrow 0.12\ C_2H_5CHO + 0.6\ C_3H_5O\text{-}CH\text{-}O\text{-}NO_2 + \text{Other products}$$

$$CH_2{=}CHCH_2CH_3 + O_3 \longrightarrow 0.35\ C_2H_5CHO + 0.41\ OH + \text{Other products}$$

$$\text{Rate} = -\left(k_{OH}[OH] + k_{NO_3}[NO_3] + k_{O_3}[O_3]\right)[\text{1-butene}]$$

$$\text{Rate} = -k_{eff}\,[\text{1-butene}]$$

Methodology: Chemistry of 1-butene

Determine ID Rxn's, E_A, k(T)
(w/ OH, NO_3, H_2O, O_3, etc.)

↓

Implement in Detailed Mechanism

↓

Run PBM as f(met parm's)

↓

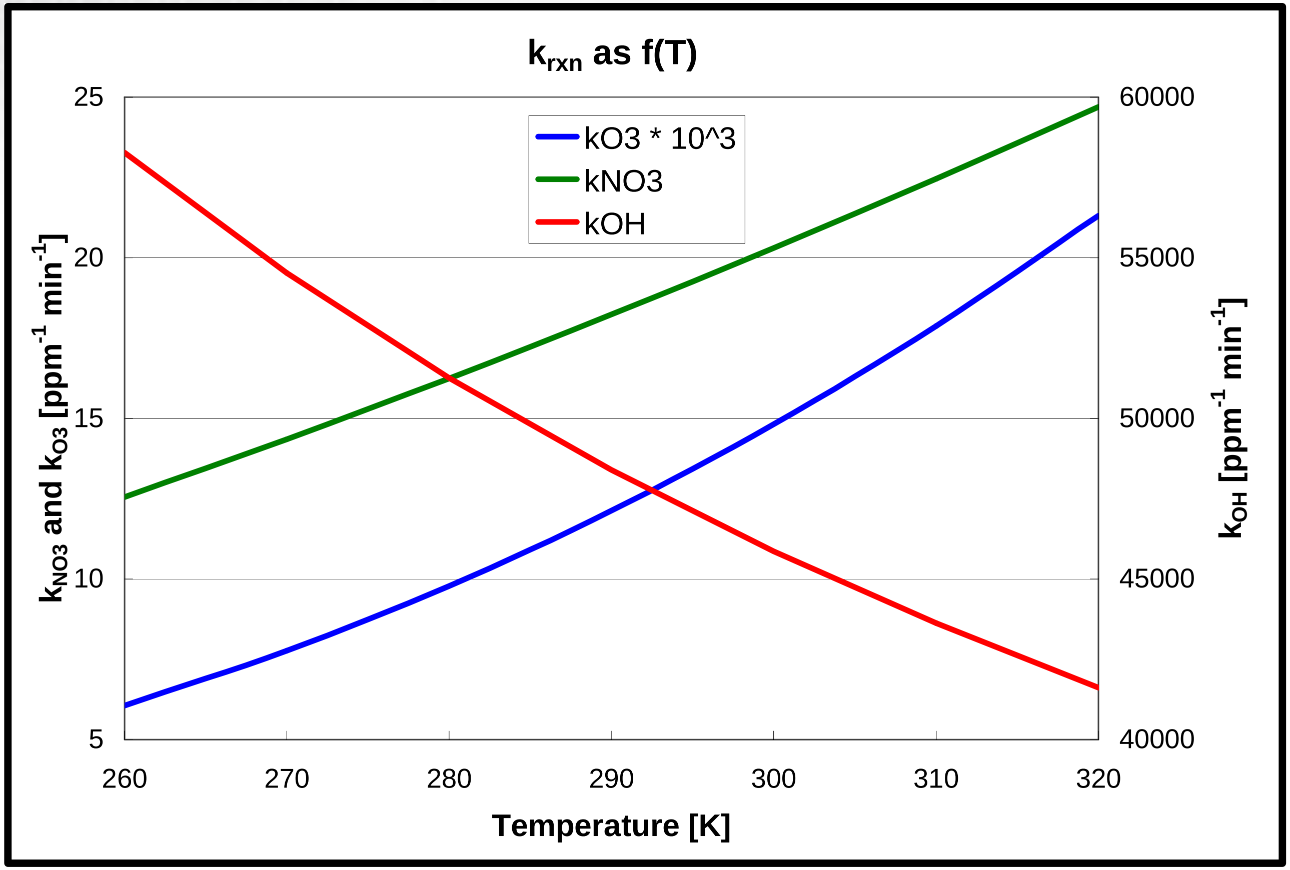
Obtain $c_{TIC}(t)$ as f(met parm's)

→

Derive Empirical k_{eff} (met parm's)

→

Populate SCIPUFF data tables w/ k_{eff} for TICs



Methodology: Detailed Mechanism

Determine
ID Rxn's, E_A, k(T)
(w/ OH, NO_3, H_2O, O_3, etc.)

Implement in Detailed Mechanism

Run PBM as f(met parm's)

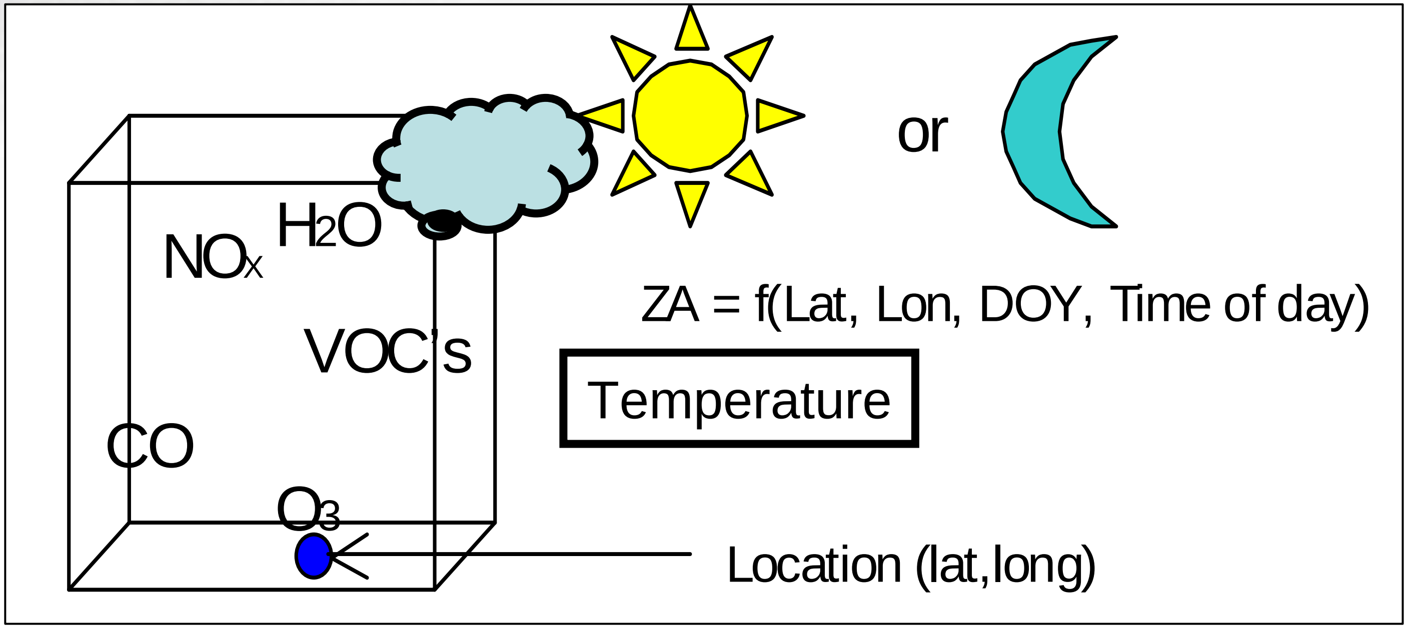
Obtain c_{TIC}(t) as f(met parm's)

Derive Empirical k_{eff} (met parm's)

Populate SCIPUFF data tables w/ k_{eff} for TICs

- **Carbon Bond Mechanism**
  - Mass consistent atmospheric chemistry mechanism.
  - EPA Model (Adelman, 1999).
  - Used to model the ambient conditions.
  - [OH], [NO_3], [O_3], NO_X, VOCs, etc..
- **Append chemistry for TIC**
  - Data provided for 9 alkenes and H_2S

Methodology: Run Detailed Chemistry



k_{eff} **is a function of solar elevation, cloud cover, air quality, temperature, humidity, etc**

Implement in Detailed Mechanism

Run PBM as f(met parm's)

Obtain $c_{TIC}(t)$ as f(met parm's)

Derive Empirical k_{eff} (met parm's)

Populate SCIPUFF data tables w/ k_{eff} for TICs

Methodology: Parameter Space

Parameter	Units	SCIPUFF
Solar Zenith Angle	0 – 90 Deg	**X**
Location (**lat**, lon)	0 – 70 Deg	**X**
Time of Day	1440 min	**X**
Day of Year	3/21, 6/20, 12/20	**X**
Photochemistry (**Cloud Cover**)	0 – 8 Eighths	**X**
Temperature	**230 – 310 K**	**X**
Water Concentration	**100 – 40000 PPM**	
Moisture Mixing ratio		**X**
Air Quality	[NO_X], VOC, O_3, …	
Land Use	Urban, ocean, forest, …	**X**

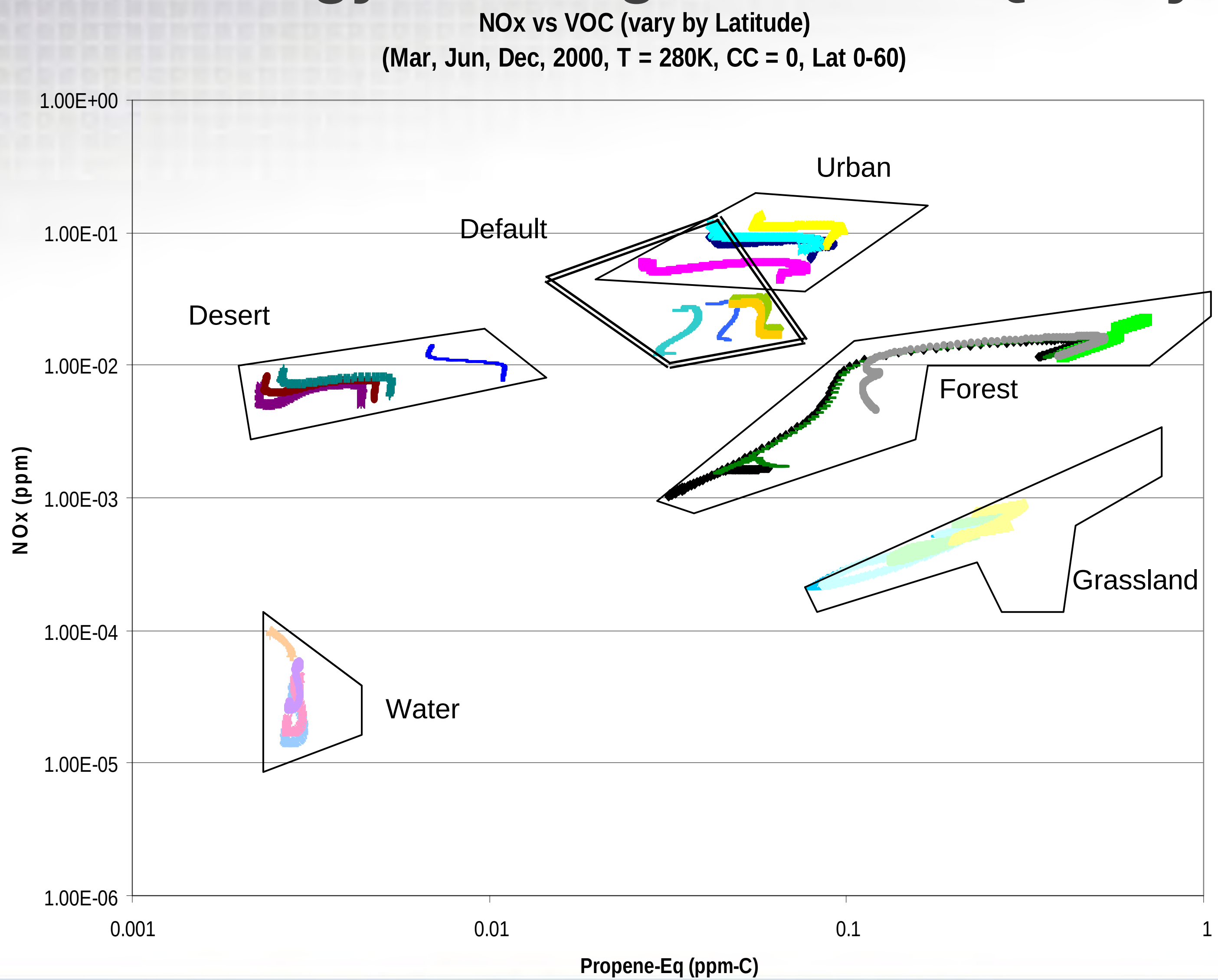
Methodology: Surrogate for Air Quality

- **Land Use**

1=Developed
2=Dry Cropland & pasture
3=Irrigated Cropland
5=Cropland/Grassland
6=Cropland/Woodland
7=Grassland
8=Shrubland
9=Shrubland/Grassland
10=Savanna
11=Deciduous Broadleaf
12=Deciduous Needleleaf
13=Evergreen Broadleaf
14=Evergreen Needleleaf
15=Mixed Forest
16=Water
17=Herbaceous Wetland
18=Wooded Wetland
19=Barren
20=Herbaceous Tundra
21=Wooded Tundra
22=Mixed Tundra
23=Bare Tundra
24=Snow or Ice
25=Partly Developed

1001=Urban Superclass
1002=Grassland Superclass
1003=Forest Superclass
1004=Desert Superclass
1005=Water Superclass

Methodology: Surrogate for Air Quality



Methodology: Refined Parameter Space (T, H_2O)

- **Surface Stations Nov 2003 – Sep 2004.**
- **Global 0.5 km LU Data Set**

1. Extracted data using 3 hr interval instead of 30 sec data. (both day and night)
2. Removed extreme data points (i.e., T<-60 °C or T<Dew point).
3. Matched weather station data with LU data before analysis (5 categories).

Latitude	Temperature (K)		$[H_2O]$ ($x10^3$) ppm	
	Min	Max	Min	Max
0	288	310	12.4	37.1
10	288	310	7.05	37.4
20	288	310	4.55	37.1
30	274	310	3.81	34.9
40	265	304	1.54	28.5
50	257	299	1.02	19.8
60	245	294	0.400	14.2
70	231	291	0.113	11.6

Methodology: Run Detailed Chemistry

$$r_i = \left(-\frac{\partial c_i}{\partial t} \right)_{Chemistry} = -k_{OH}[OH][c_i] - k_{NO_3}[NO_3][c_i] - k_{O_3}[O_3][c_i] - k[c_i] - \ldots..$$

$$-\left(\frac{dc_i}{dt} \right)_{chemistry} = k_{eff}[c_i]$$

$$k_{eff} = \frac{-\frac{dc}{dt}}{[c]}$$

Implement in Detailed Mechanism → **Run PBM as f(met parm's)** → **Obtain $c_{TIC}(t)$ as f(met parm's)** → **Derive Empirical k_{eff} (met parm's)** → **Populate SCIPUFF data tables w/ k_{eff} for TICs**

Methodology: Obtain C_{TIC} as f(t)

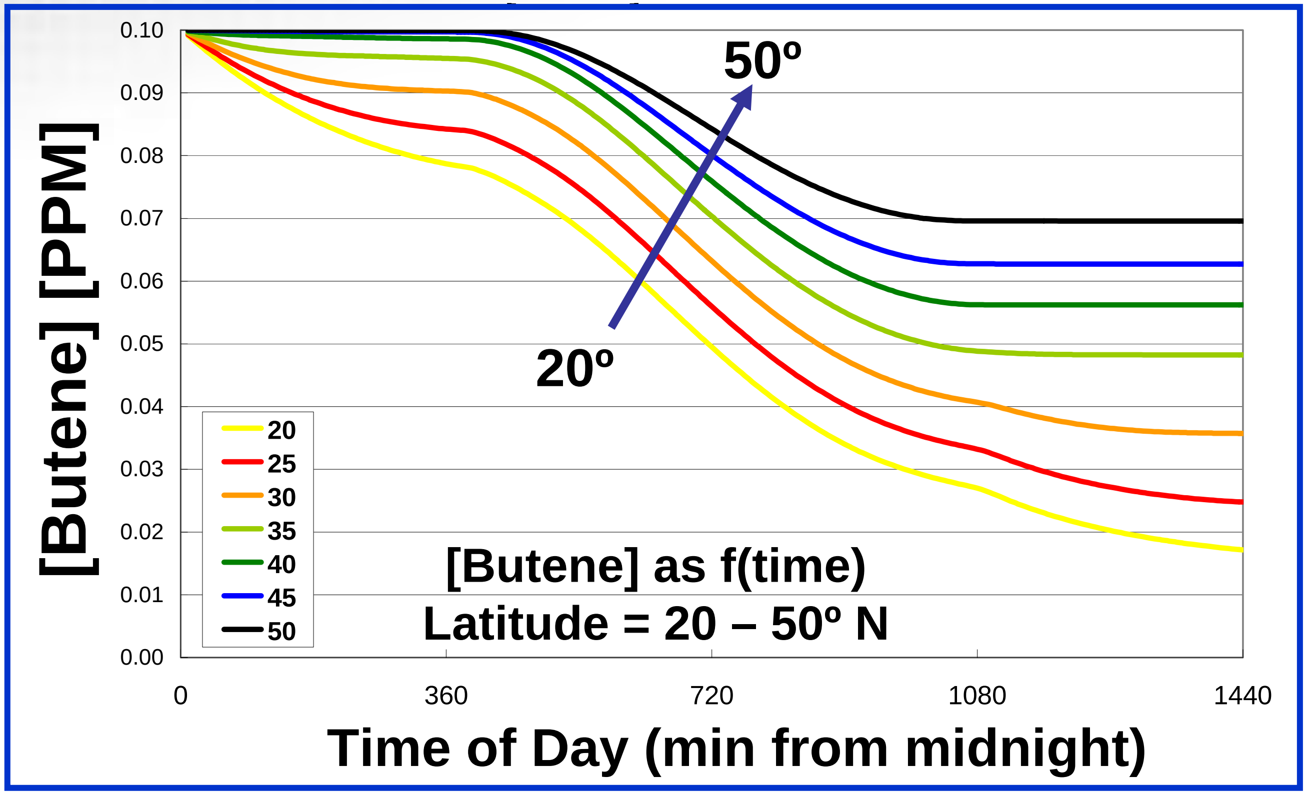
$$k_{eff} = \frac{-\frac{dc}{dt}}{[c]}$$

Implement in Detailed Mechanism

Run PBM as f(met parm's)

Obtain $c_{TIC}(t)$ as f(met parm's)

T = 290 K, Land Use = Urban



Derive Empirical k_{eff} (met parm's)

Populate SCIPUFF data tables w/ k_{eff} for TICs

Methodology: Obtain k_{eff} as f(met parms)

$$k_{eff} = \frac{-\dfrac{dc}{dt}}{[c]}$$

Implement in Detailed Mechanism

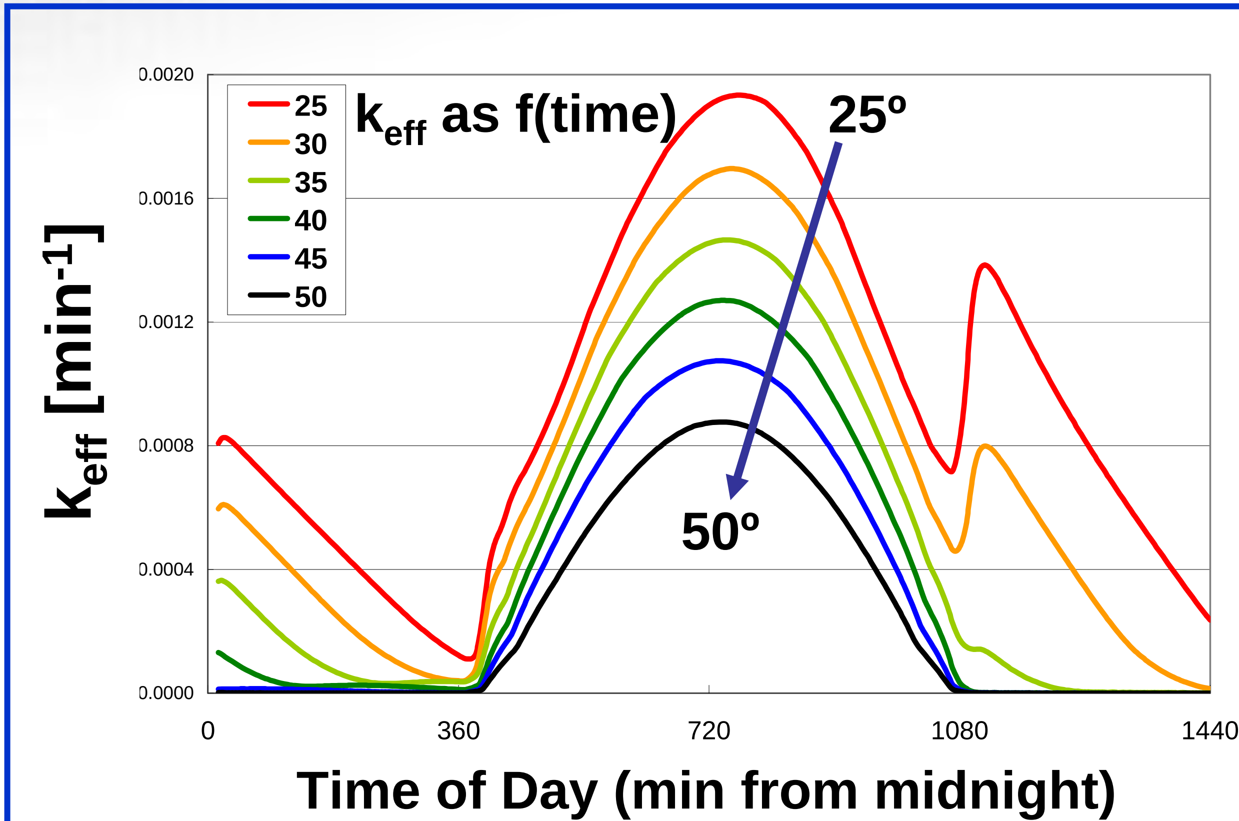
Run PBM as f(met parm's)

Obtain $c_{TIC}(t)$ as f(met parm's)

Derive Empirical k_{eff} (met parm's)

Populate SCIPUFF data tables w/ k_{eff} for TICs

T = 291 K, Land Use = Urban



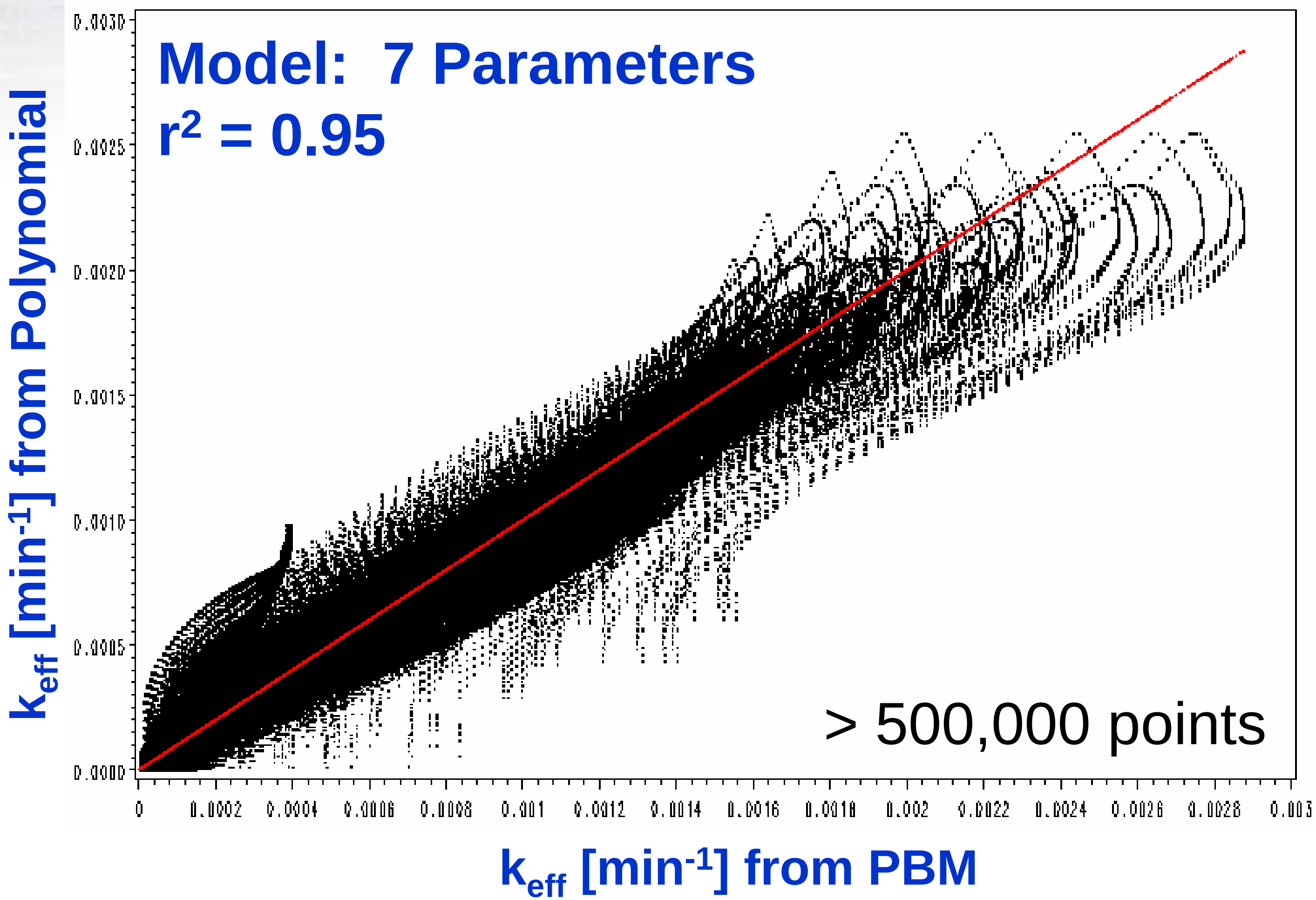
Methodology: Derive Empirical k_{eff}

- Generate k_{eff} for various combinations of meteorological parameters for each land use
- Transform data to center on all parameters
- Perform statistical regression - correlation
  - Review Equation
  - Review Statistical Parameters (e.g., r^2)
  - Weigh fit vs number of parameters
- Derive an empirical k_{eff} = f(SE, T, lat, tod, CC, [H_2O])
- Compare the k_{eff} (empirical model) with the PBM derived k_{eff}.

Obtain $c_{TIC}(t)$ as f(met parm's) → **Derive Empirical k_{eff} (met parm's)** → **Populate SCIPUFF data tables w/ k_{eff} for TICs**

Results: k_{eff} (polynomial) vs k_{eff} (PBM) for butene

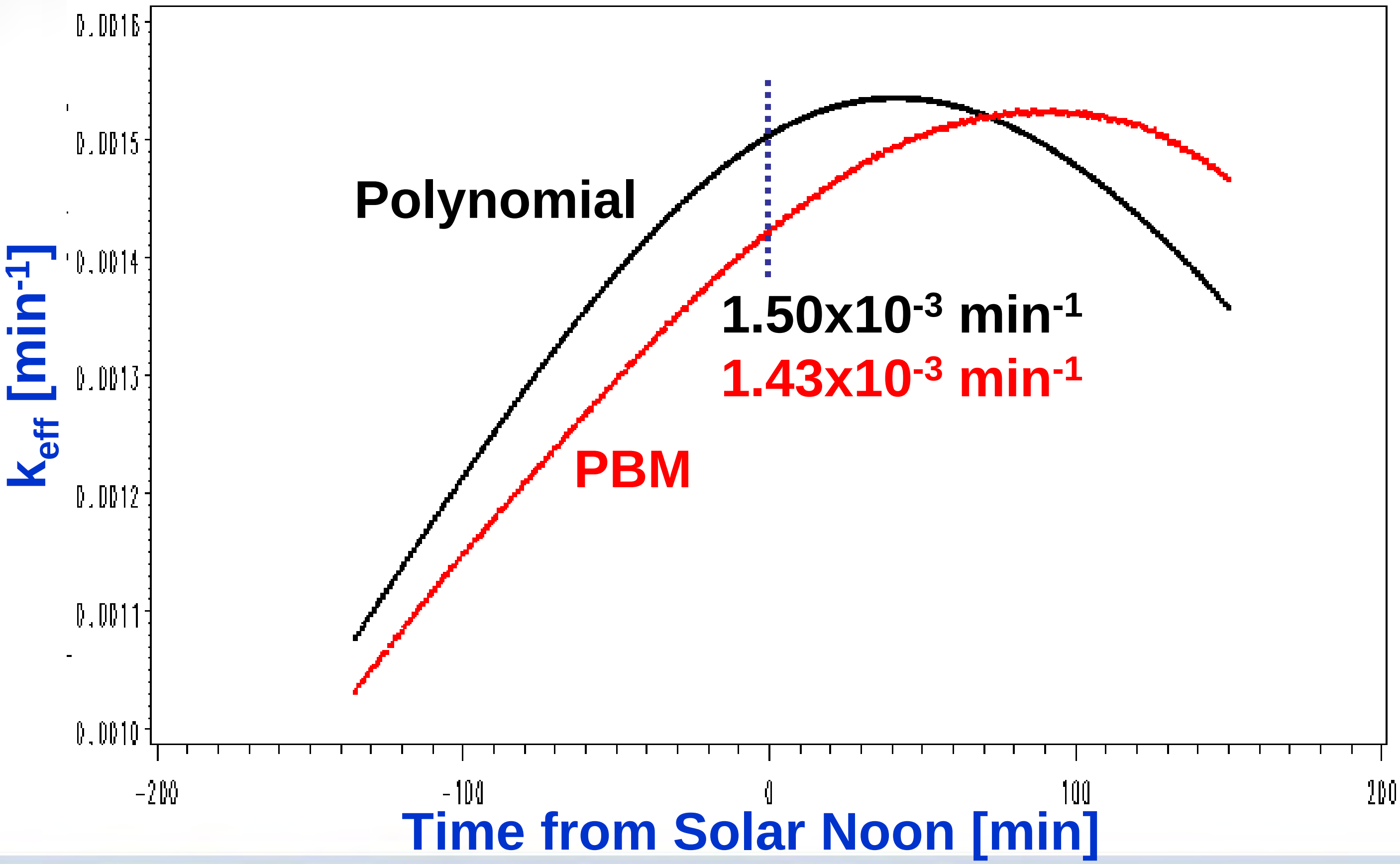
Land Use = Urban



Results: k_{eff} (polynomial) vs k_{eff} (PBM) for butene

Land Use = Grass

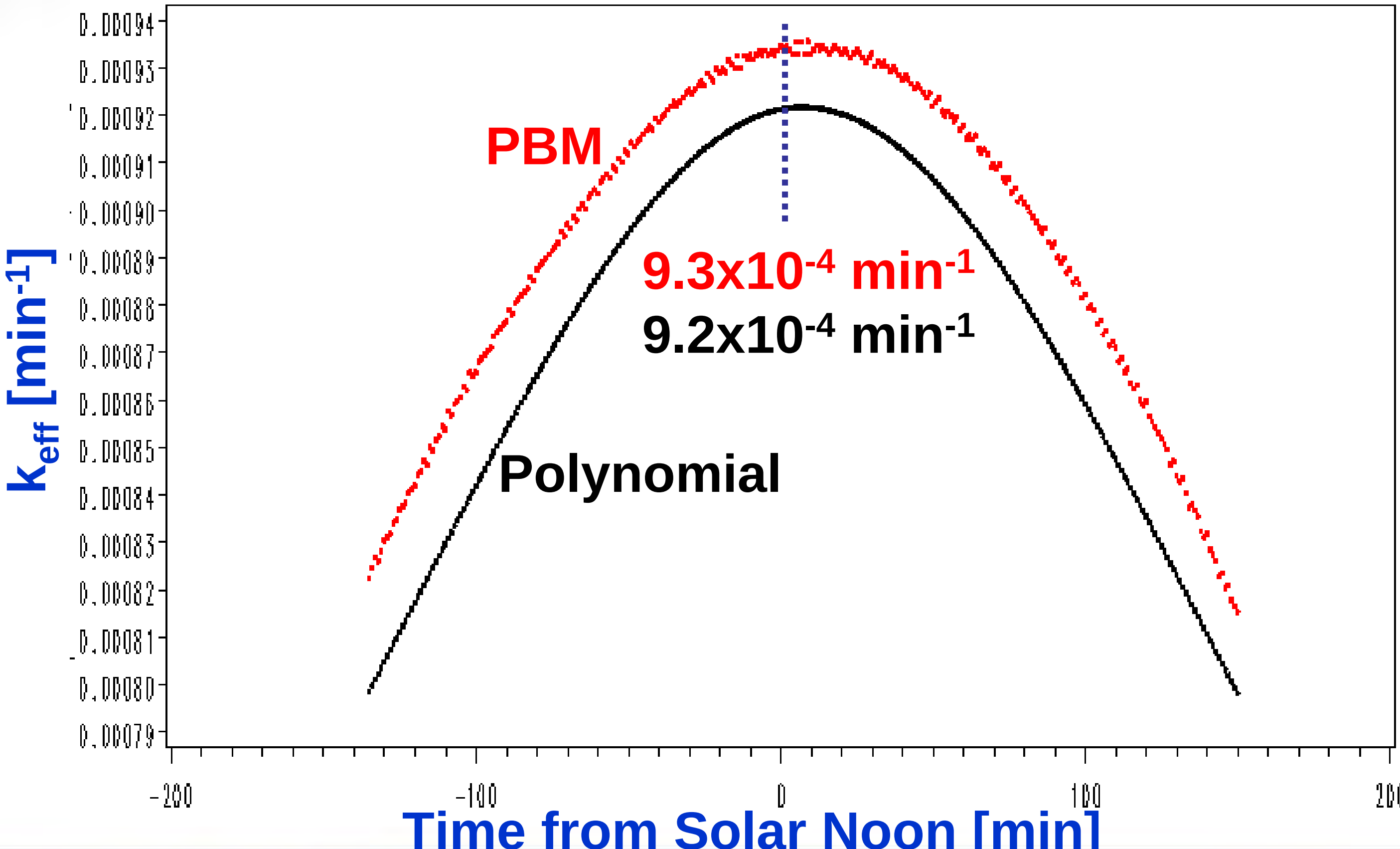
Lat 0°, Temp 300 K, Cloud Cover 0/8, $[H_2O]$ = 20000 ppm,



Results: k_{eff} (polynomial) vs k_{eff} (PBM) for butene

Land Use = Water

Lat 0°, Temp 300 K, Cloud Cover 0/8, [H_2O] = 20000 ppm,



Methodology: Obtain X_{eff}

$$CH_2{=}CHCH_2CH_3 + OH \longrightarrow 0.94\ C_2H_5CHO + \text{Other products}$$

$$CH_2{=}CHCH_2CH_3 + NO_3 \longrightarrow 0.12\ C_2H_5CHO + 0.6\ C_3H_5O\text{-}CH\text{-}O\text{-}NO_2 + \text{Other products}$$

$$CH_2{=}CHCH_2CH_3 + O_3 \longrightarrow 0.35\ C_2H_5CHO + 0.41\ OH + \text{Other products}$$

$$\text{Rate} = -\left(k_{OH}[OH] + k_{NO_3}[NO_3] + k_{O_3}[O_3]\right)[\text{1-butene}]$$

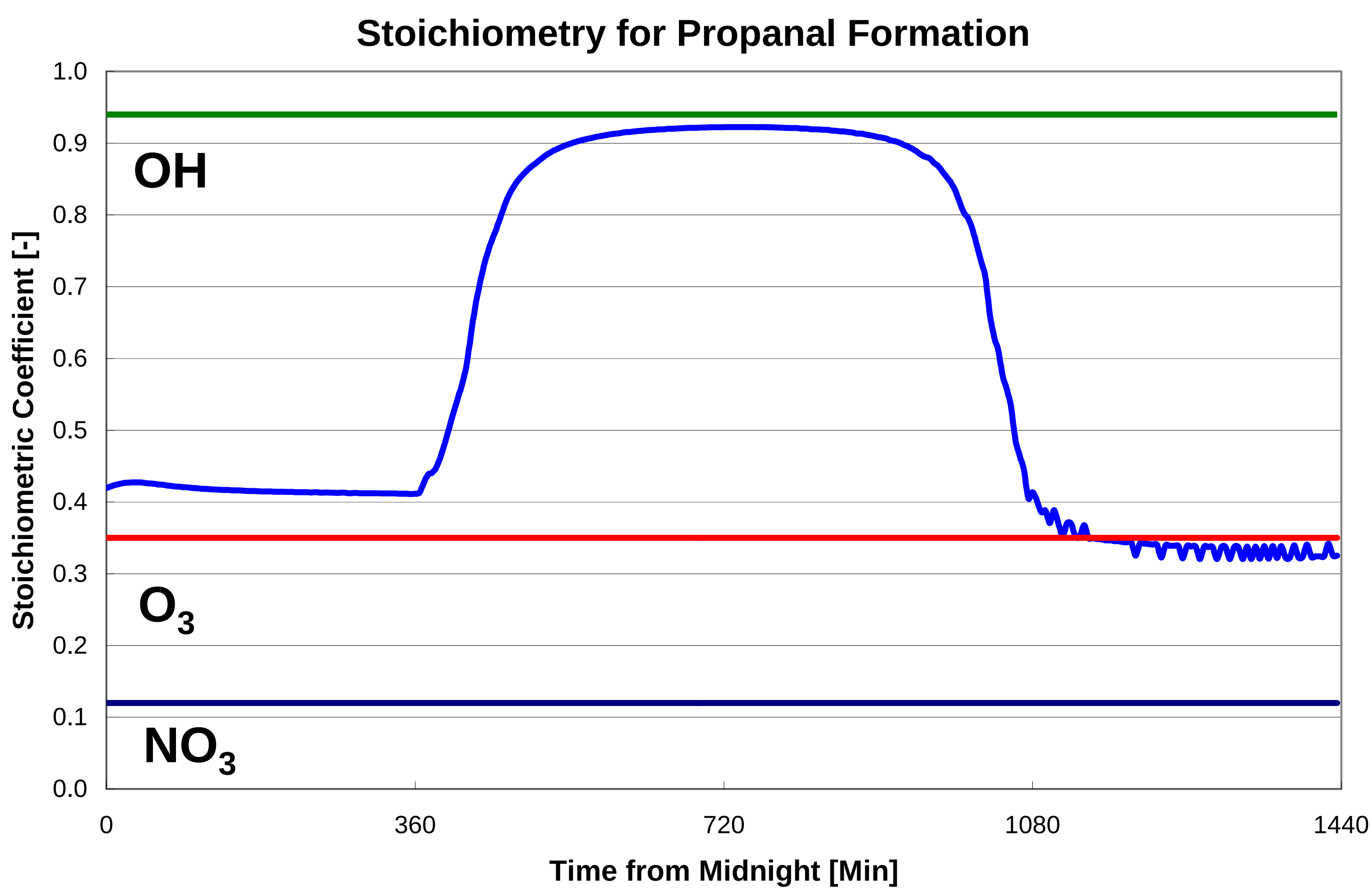
$$\text{Rate} = -k_{eff}\,[\text{1-butene}]$$

$$\text{Rate} = +\left(0.94\,k_{OH}[OH] + 0.12\,k_{NO_3}[NO_3] + 0.35\,k_{O_3}[O_3]\right)[\text{butene}]$$

$$\text{Rate} = +X_{eff}\,k_{eff}\,[\text{1-butene}]$$

Methodology: Obtain X_{eff}

T = 295 K, Land Use = Water



Results: Nine Alkenes

- Priority I
  - **1-Butene**
    - Products (**Propanal**, Nitroxybutanone).
  - Ethene
  - Propene
  - **Methylpropene**
  - 1,3-Butadiene
- Priority II
  - Styrene
- Priority III
  - cis-2-Butene
  - trans-2-Butene
  - Isoprene

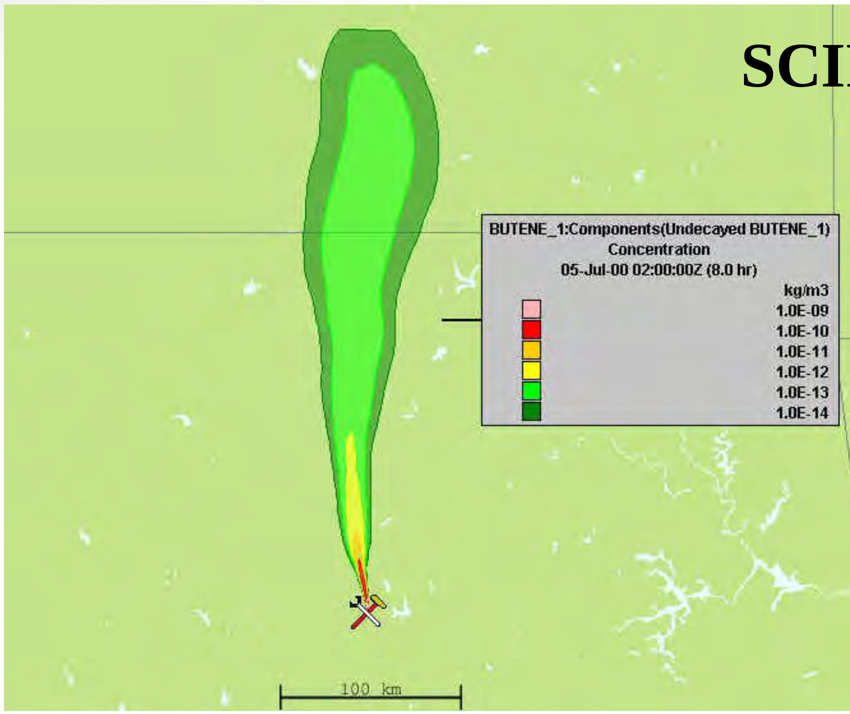
Why Chemistry is Important in AT&D Modeling

Results: T&D Compared to T&D + Chemistry (Butene)

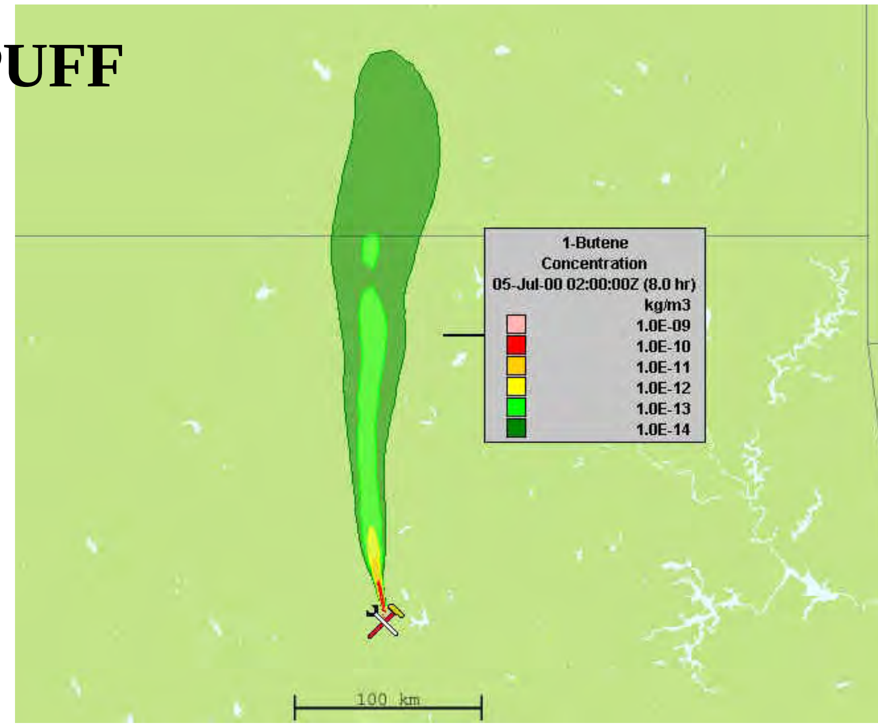
T&D Only

T&D + Chemistry

SCIPUFF



Tracer

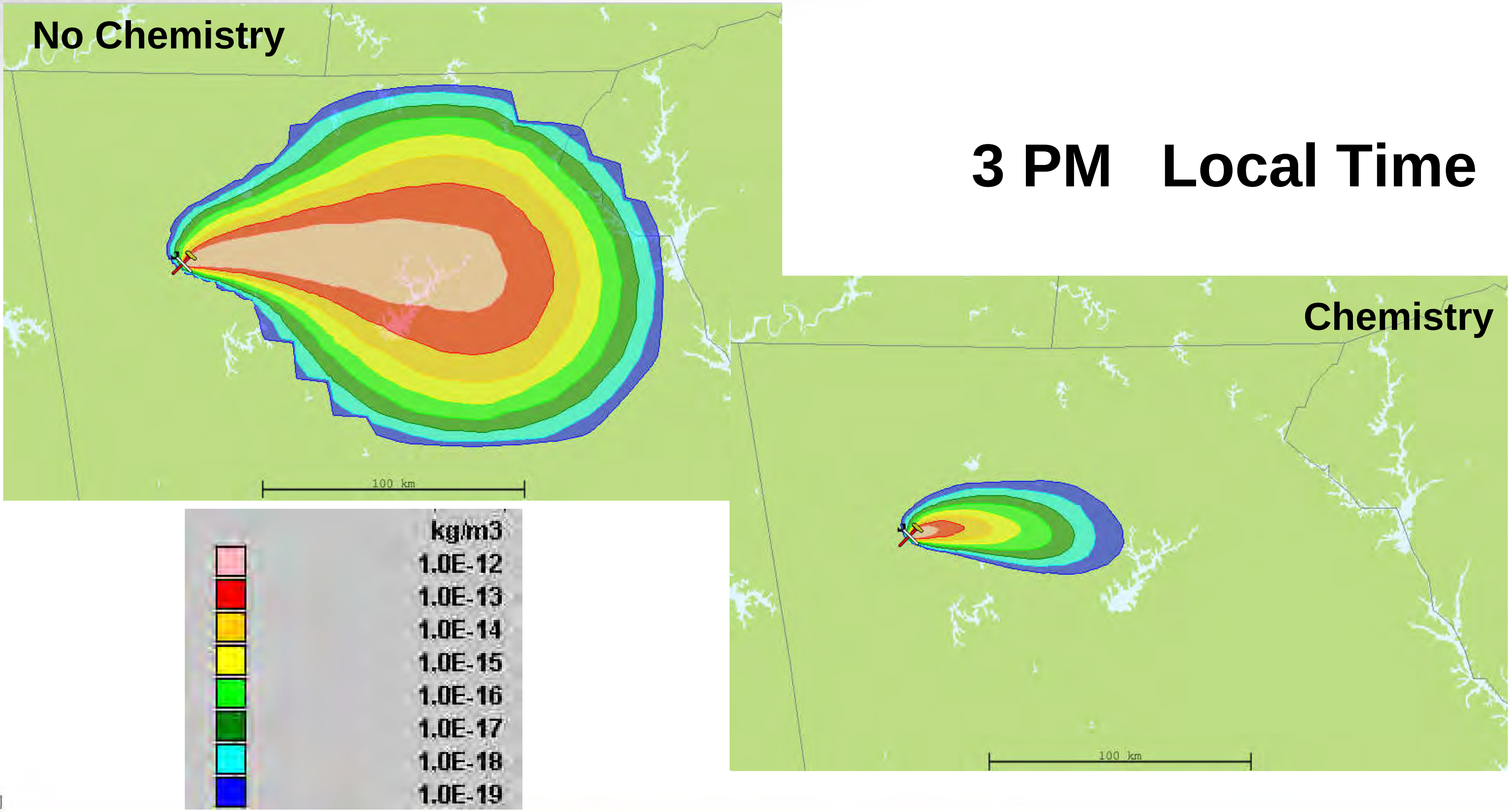


1-Butene

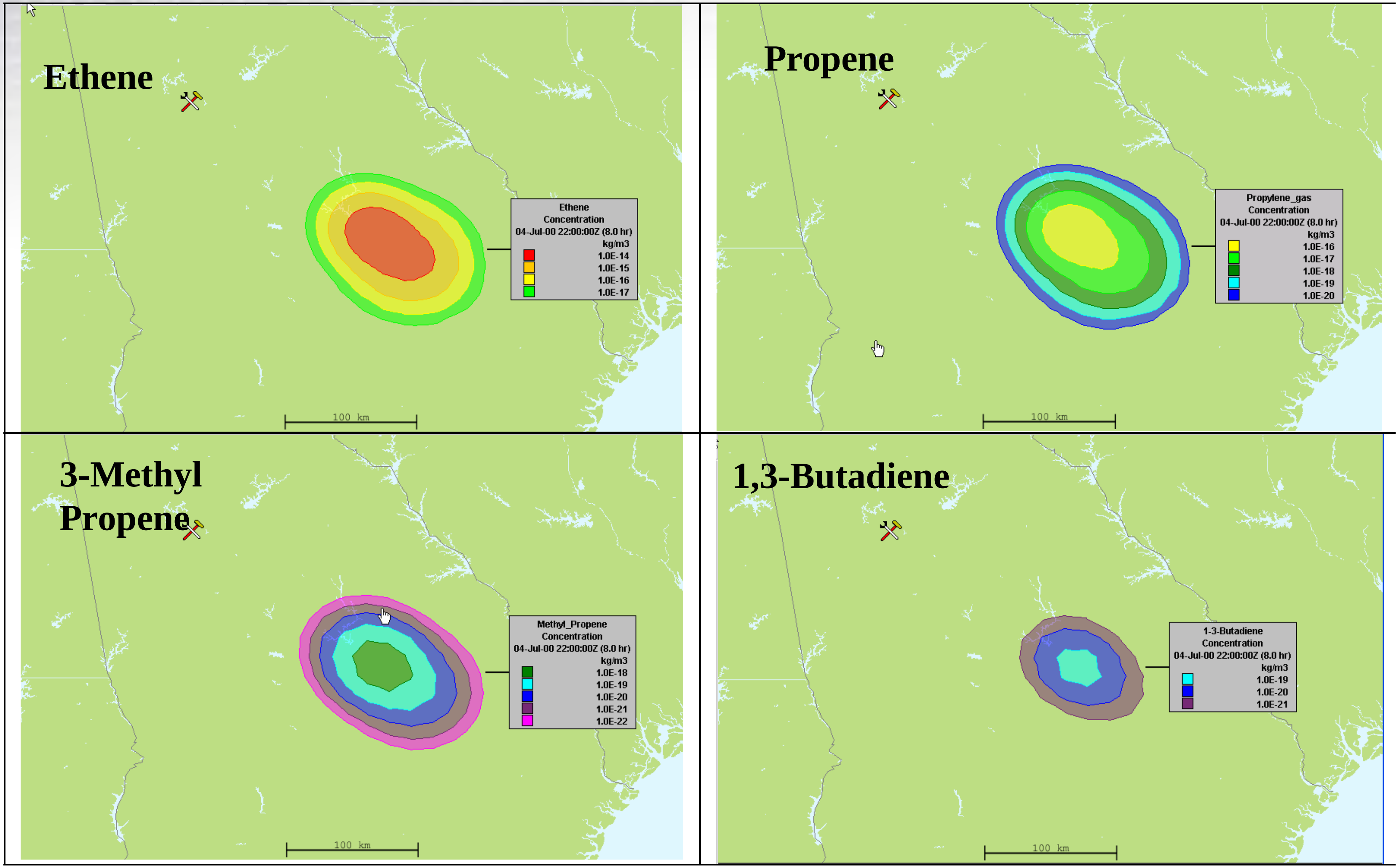
Results: Methylpropene

8 hr continuous release starting at 8 am local time

3 PM Local Time

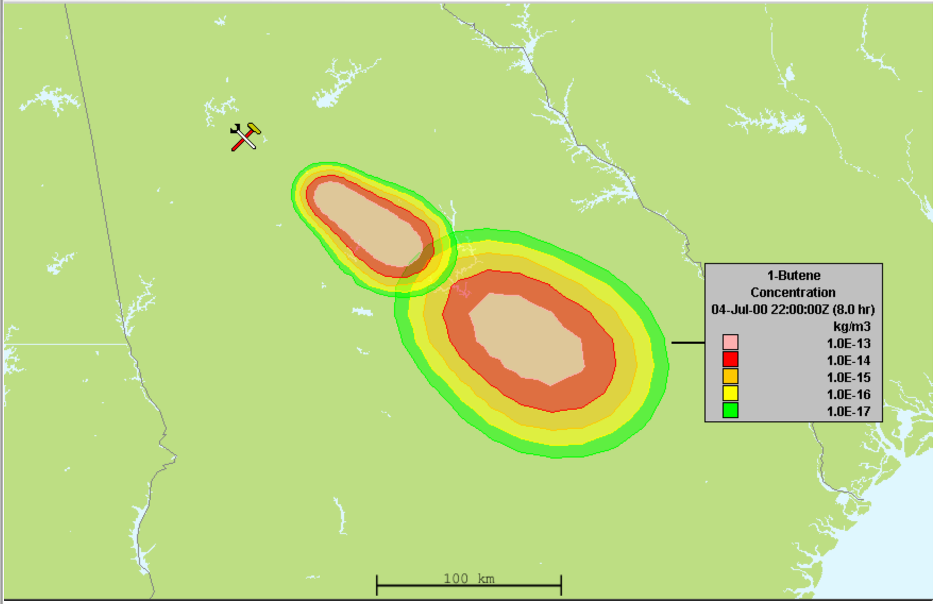


Results: Calculated Plume is TIC Dependent

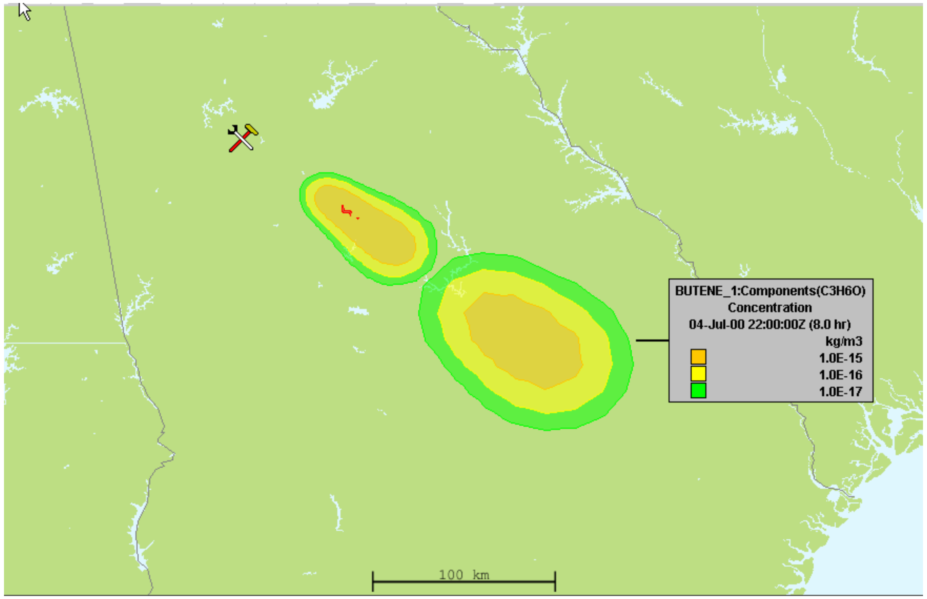


Results: TIC Decay and Product Formation

1-Butene



Propanal

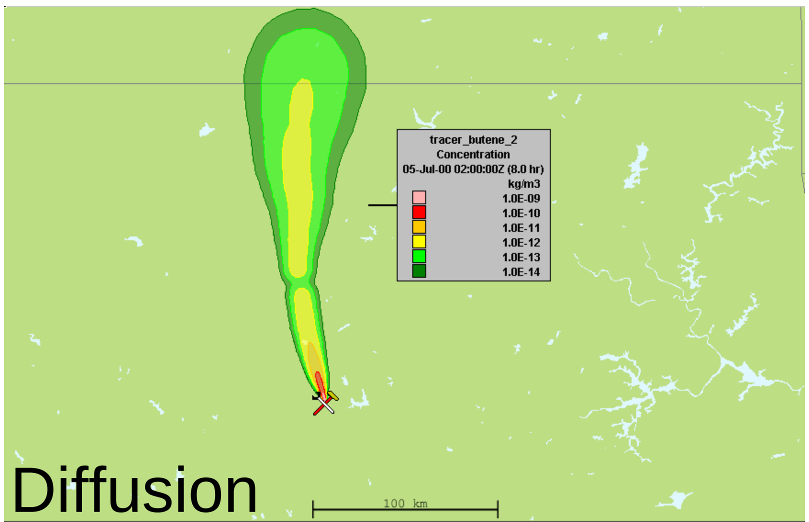


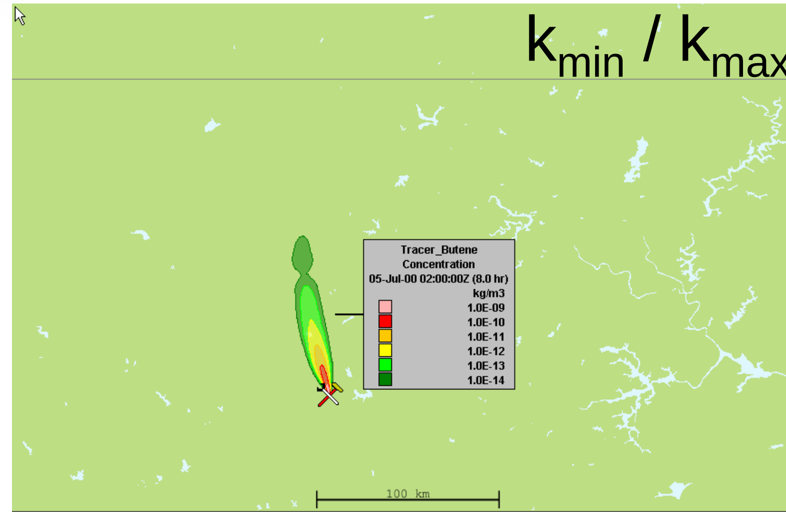
At 4 hrs and 8 hrs after release

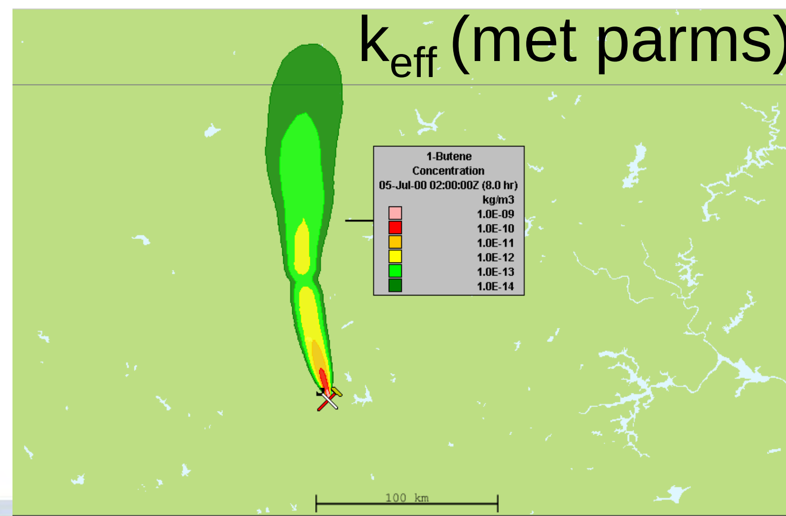
2 hr continuous release starting at noon local time

Results: Test and Evaluate (Output)

Comparison of Original SCIPUFF and “Degrade”





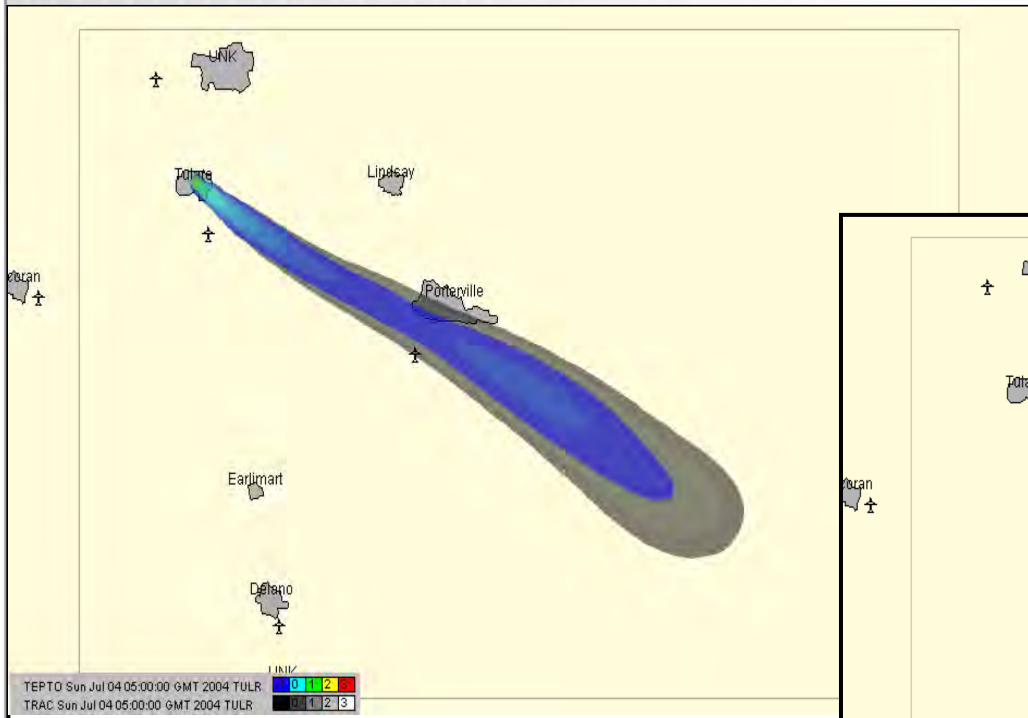


Summary & Future Work

- Developed Chemistry Model for 10 TICs
  - 9 Alkenes + H_2S
- No slow down in SCIPUFF
- Ability to model product formation
- Future Work
  - Site specific k_{eff}'s
  - k_{eff}'s for other TICs
    - Complementary lab / theory development of fundamental k_{OH}, k_{O3}, k_{H2O}, etc.
  - Chamber Studies (Chemistry Validation)
  - Field Studies (Model Validation)

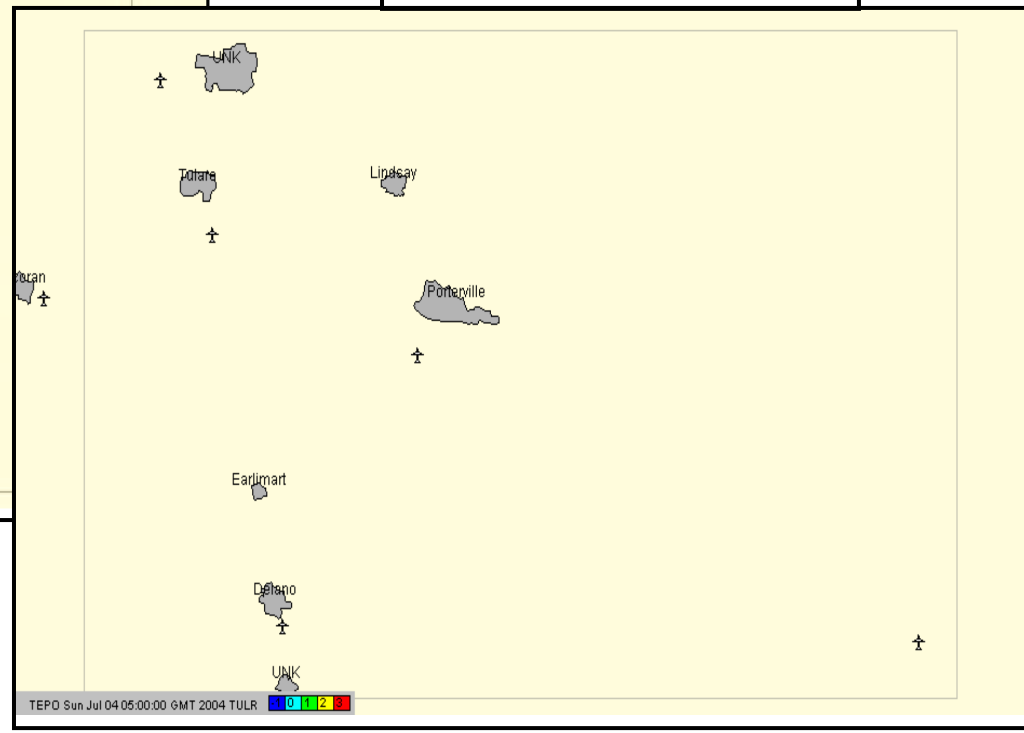
End of slides

Example: Crop Dusting Scenario – Bottom line



Chemistry vs T&D

Degrade Generation



03 July 22:00 (Local) 05:00 Z

MONOTONE MEASURE THEORY AS A METHOD FOR COMBINING EVIDENCE IN THREAT SCENARIOS

Greg M. Chavez,

Timothy J. Ross,

Mahmoud Reda Taha,

Ram Prasad

October 2005

Purpose

- Pose a simple problem involving two uncertainties:
  - the uncertainty in the assignment of an event to two or more possible sets.
  - the uncertainty found in the boundary (description) of the possible sets.
- Present an approach for accounting for both uncertainties in a CB model in a natural manner.
- Demonstrate the proposed approach in an example where a Chemical/Biological weapon attack has occurred and the likelihood of casualties resulting from the attack is needed.

A simple decision support system (DSS) modeling casualties resulting from a chem/bio attack.

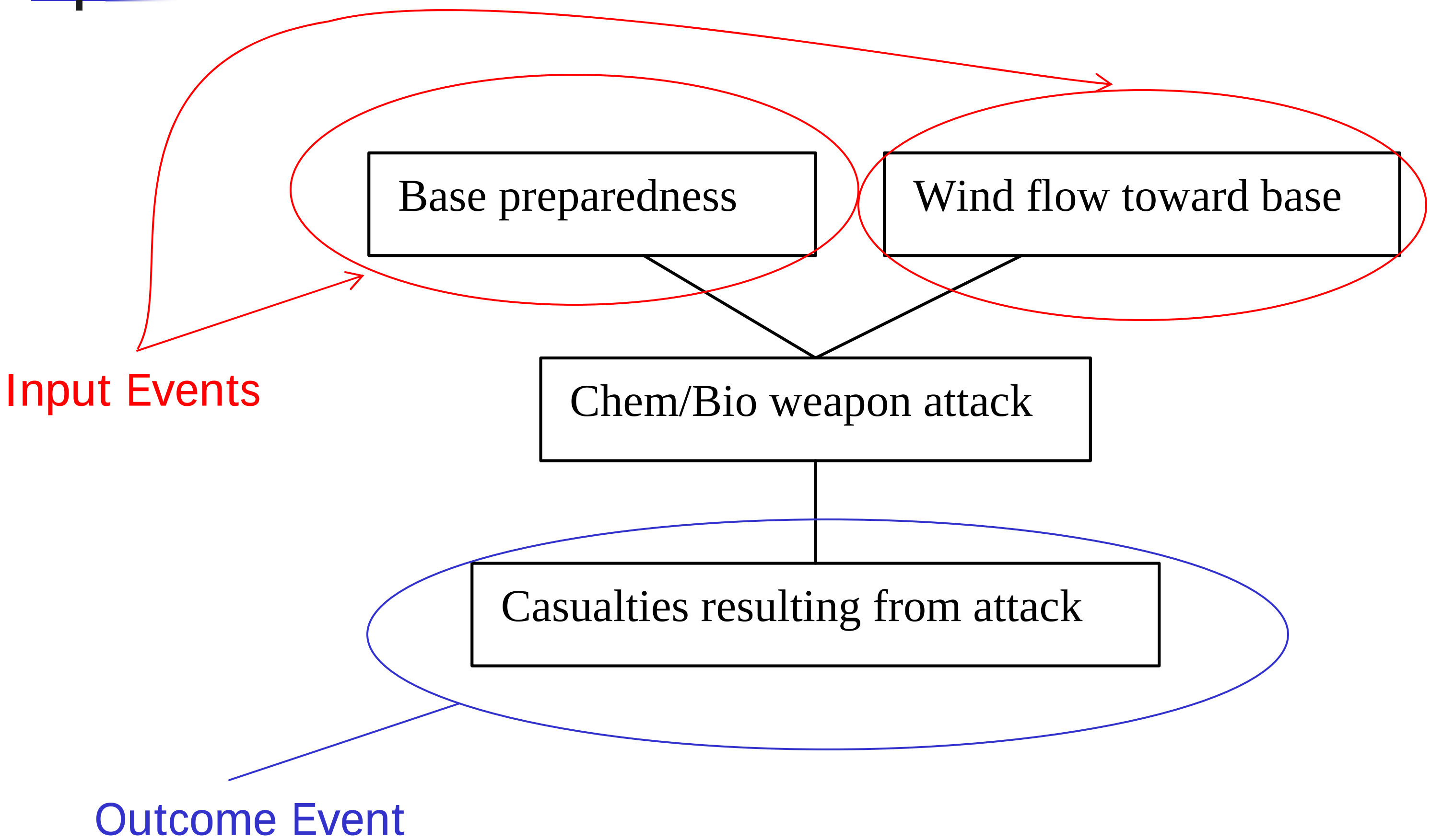


Figure 1

Problem: source data contain two uncertainties for wind flow

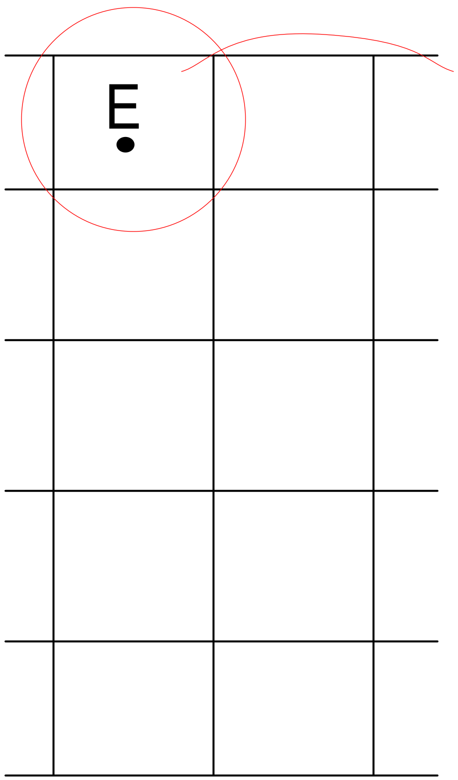
- Suppose both uncertainties exist in the source information for the wind flow.
  - The knowledge base for wind flow consists of approximate linguistic sets (with boundary uncertainty).
  - The wind flow at the base that is attacked is “x” and has a degree evidence in each set of the knowledge base (assignment uncertainty).

Object of this study:

To account for all source information in the DSS model, i.e. both types of uncertainty: boundary (fuzziness) and assignment (ambiguity) uncertainty.

Types of sets

Crisp Sets



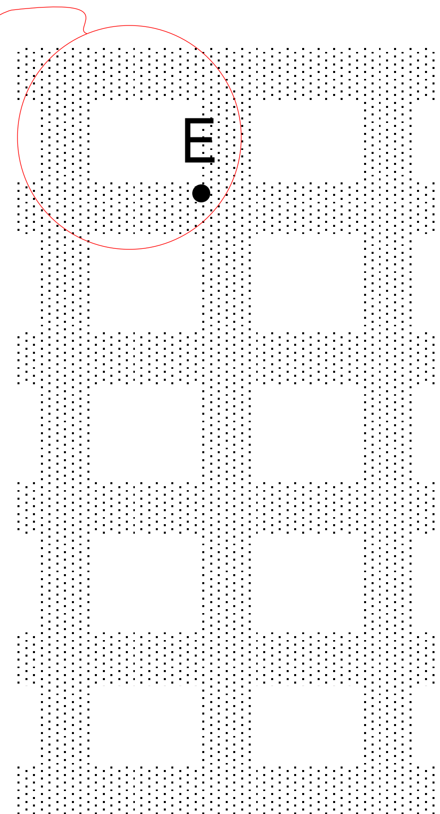
Only assignment uncertainty

E *is an event*

Each square of the grid represents boundary of a set describing the event.

In the fuzzy set **E** *is only partially described by the set.*

Fuzzy Sets



Boundary uncertainty

Types of sets

Crisp Sets

No Boundary Uncertainty ***"Crisp Set"***

•The box represents the set describing the event.

•The boundary of the set is well defined and understood.

•The elements are either members of the set A or not, membership in the set is binary, or equal to 1 or 0.

Fuzzy Sets

Boundary Uncertainty ***"fuzzy set"***

•The fuzzy box represents the set containing the event.

•The boundary of the set is vague or fuzzy; not clear like "tall" or "heavy".

•The elements can have partial membership in a set; membership varies on the interval from 0 to 1.

The importance of this study

1. Both assignment and boundary uncertainty should adequately be accounted for in a DSS.

2. Previous approaches do not adequately account for both uncertainties or are not applicable here.

Proposed Approach

- Input: the input events x and a frame of discernment (knowledge base) **X**. Membership functions for the sets of **X** and the degree of evidence for x in the sets.

$$\tilde{B}, \tilde{C} \subset \mathbf{X}$$

*Membership functions are used to obtain the membership value for event (to be shown).

Degree of evidence for input event x_i is a particular set of **X**.

$$\text{Degree of evidence}$$

$$m_{\tilde{B}}(x_i)$$

$$m_{\tilde{C}}(x_i)$$

Proposed approach

- *Step 1, obtain membership value from membership function for the event value, i.e. wind flow.*

- Event = x_i

$\mu_{\tilde{B}}(x_i)$ Membership values in sets

$\mu_{\tilde{C}}(x_i)$

Preliminary Approach

- *Step 2, Obtain percentage of the fuzzy set represented by the degree of membership in the degrees of evidence.*

$$\eta_{\tilde{B}} = m_{\tilde{B}}(x_i) * \mu_{\tilde{B}}(x_i)$$

$$\eta_{\tilde{C}} = m_{\tilde{C}}(x_i) * \mu_{\tilde{C}}(x_i)$$

Preliminary Approach

- *Step 3, Normalize the degrees of evidence to obtain updated degree of evidence.*

$$\boldsymbol{m}_{\tilde{B}}(x_i) = \frac{\eta_{\tilde{B}}}{\eta_{\tilde{C}} + \eta_{\tilde{B}}}$$

$$\boldsymbol{m}_{\tilde{C}}(x_i) = \frac{\eta_{\tilde{C}}}{\eta_{\tilde{C}} + \eta_{\tilde{B}}}$$

Satisfaction of monotone measures

- Satisfies two conditions essential for monotone measures.

$$m(\emptyset) = 0$$

$$\sum_{A \in P(X)} m(A) = 1$$

where P(X) is the set that includes all subsets of the frame of discernment, X, i.e. all subsets of the power-set.

An attack has occurred

- The likelihood for casualties resulting from a chemical or biological attack that has occurred in close proximity to a military base can be inferred from the available evidence for the sets of the input events.

- Each event can be assigned to the sets that describe the event with an associated amount of evidence through expert elicitation. Base preparedness is described by two crisp sets: “Unprepared” and “Prepared”. Wind flow is described by fuzzy sets, “Directly towards base”, “Near base vicinity”, and “directly away from base.”

- The degree of evidence for the outcome sets is inferred with a rule base developed by experts.

Sets for input events

Events and the sets that describe events

Event	*Sets describing event*	
(Base preparedness)	“Base prepared” Y	“Base unprepared” N
(Wind flow direction)	“Directly towards base” $\tilde{A}$	“Directly away from base” $\tilde{C}$
	“Flow near base vicinity” $\tilde{B}$	
(Casualties resulting from attack)	“No casualties” O_1	“Few casualties” O_2
	“Moderate casualties” O_3	
	“Heavy casualties” O_4	

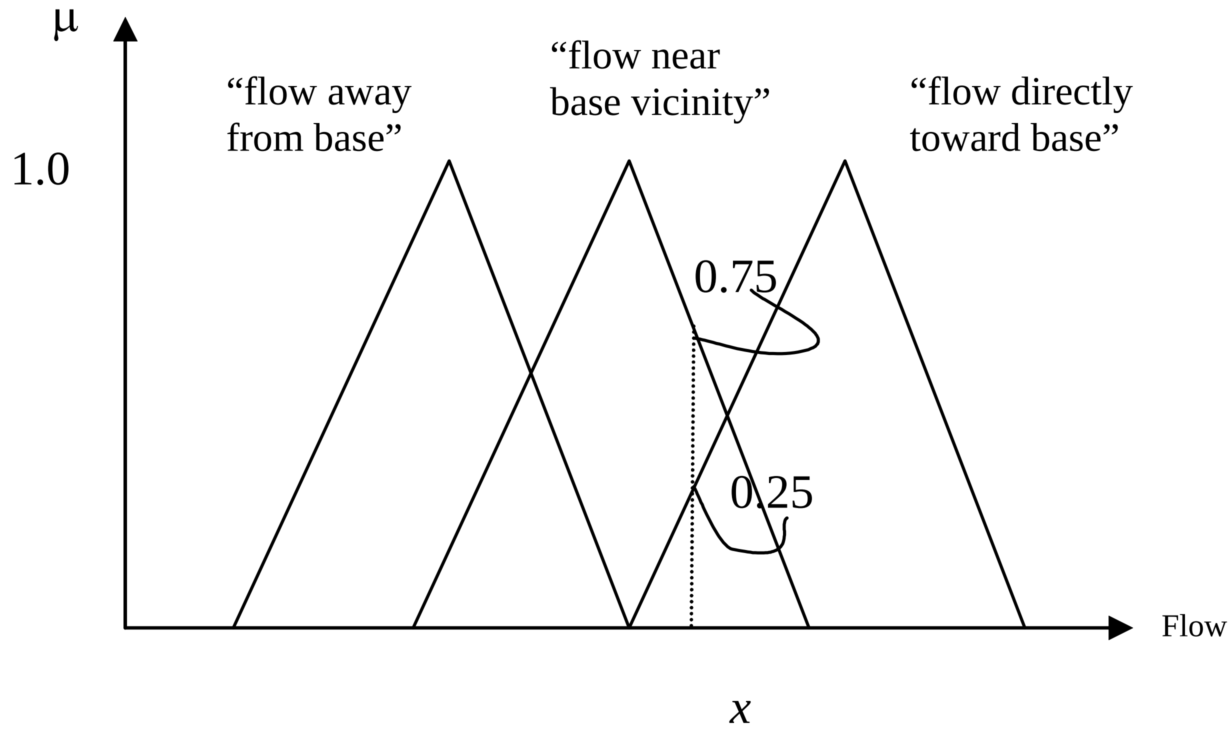
Rule base from experts

Rule base used to infer the casualty likelihood

	Base Preparedness	
Wind flow	Y	N
$\tilde{A}$	O_2	O_4
$\tilde{B}$	O_1	O_3
$\tilde{C}$	O_1	O_1

Note, there are four possible outputs, O_1, O_2, O_3, and O_4 which correspond to "no", "few", "moderate", and "high" casualties, respectively.

Membership functions for wind flow



Membership functions for casualties, showing the degree of membership value for x casualties. The uncertainty in the boundary is portrayed in the gradual transition of membership

Source information for base preparedness and wind flow

Evidence assignment for base preparedness

Base Preparedness	
Set	Degree of evidence
Y	$m_Y = 0.822$
N	$m_N = 0.178$

Evidence assignment for a specific wind flow, x

Wind Flow	
Set	Degree of evidence
$\tilde{A}$	$m_{\tilde{A}} = 0.7$
$\tilde{B}$	$m_{\tilde{B}} = 0.8$

Note, the membership in the third fuzzy set for wind, i.e. for "flow away from base"
Is zero, as can be seen in the previous graph of membership functions

Problem: fusing both boundary uncertainty and assignment uncertainty for wind flow

- Applying the fusing approach presented earlier, the boundary uncertainty can be accounted for in the evidence of wind flow.
- Our approach results in fused degrees of evidence for wind flow of:

$$m_{\tilde{A}} = 0.4375$$

$$m_{\tilde{B}_1} = 0.5625$$

The resulting assignment of evidence for the solution (using an inference method)

$$m(O_2) = m_{11} \wedge m_{21} = \min(0.4375, 0.822) = 0.4375$$
$$m(O_1) = m_{12} \wedge m_{21} = \min(0.5625, 0.822) = 0.5625$$
$$m(O_4) = m_{11} \wedge m_{22} = \min(0.4375, 0.178) = 0.178$$
$$m(O_3) = m_{12} \wedge m_{22} = \min(0.5625, 0.178) = 0.178$$

Therefore, a chem/bio weapon attack on this particular base has a likelihood in the set of *no casualties* of 0.5625, in the set of *few casualties* of 0.4375 and in the sets of *moderate* and *high casualties* of 0.178 each.

Conclusions

- Approach extends the traditional separate approaches of inferring an assignment of evidence with crisp sets to include fuzzy sets.
- The approach was demonstrated with a simple example of a terrorist attack on a military base using a chem/bio weapon. This can be extended to a more complicated terrorist attack.

[redacted]

Nowcasting and Urban Interactive Modeling Using Robotic and Remotely Sensed Data

James Cogan, Robert Dumais, and Yansen Wang

Meteorological Modeling Branch
Battlefield Environment Division
Computational & Information Sciences Directorate
U.S. Army Research Laboratory

OUTLINE

1. Overall System Concept

2. Met Spaces

3. Platforms

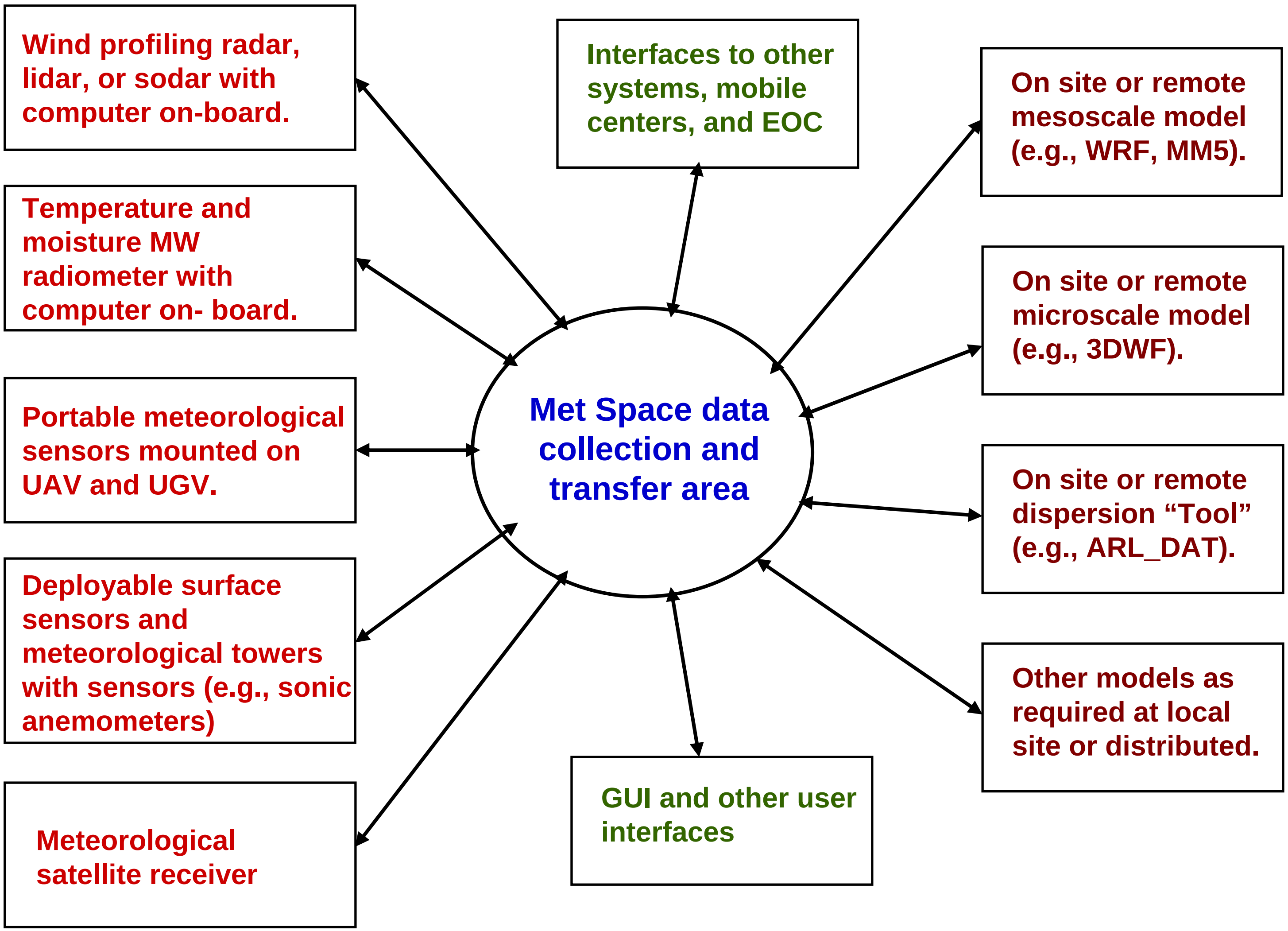
4. Sensors

5. Models and Weather Running Estimate – Nowcast (WRE-N)

6. One Concept of Distributed Operation

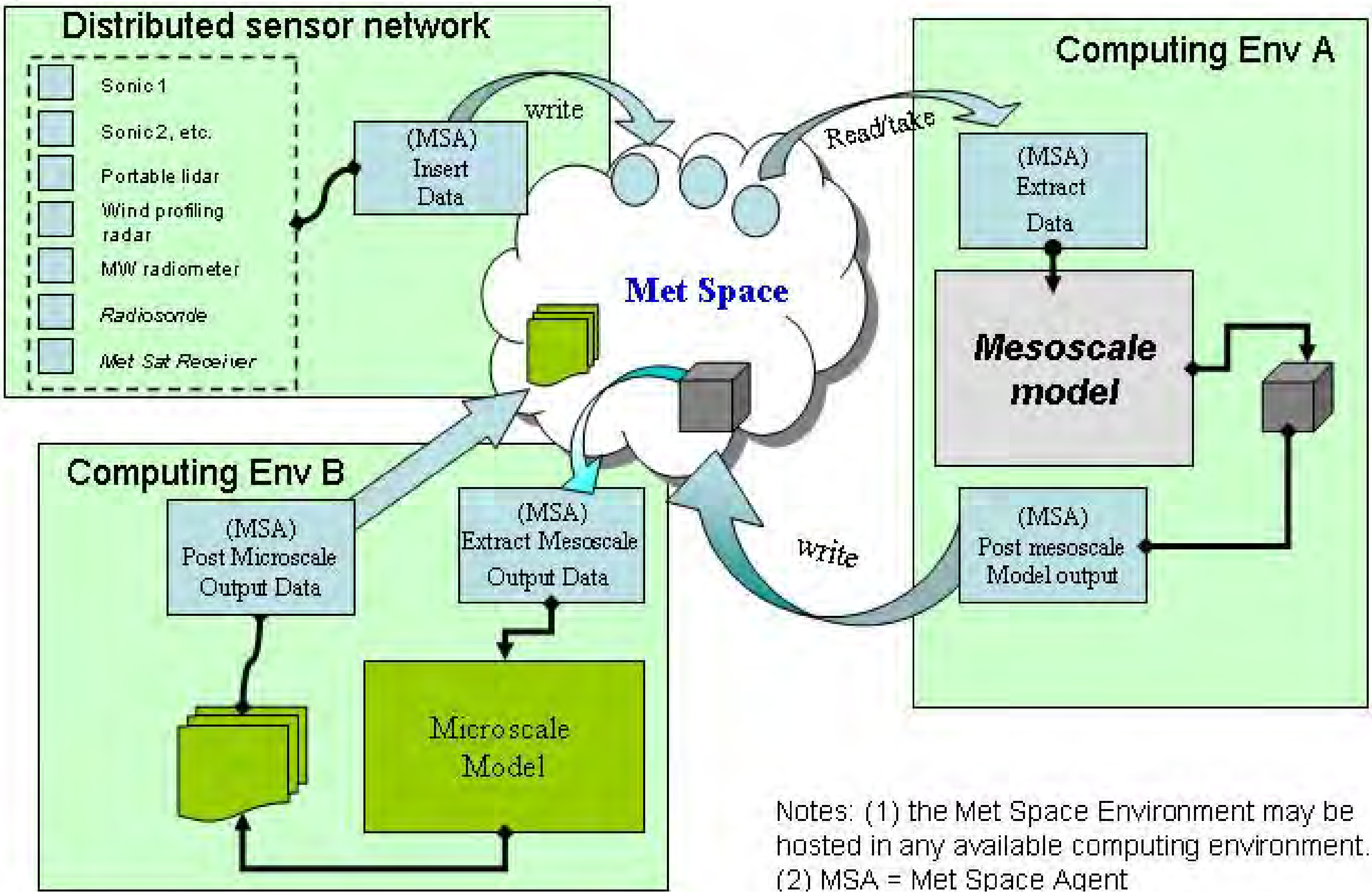
7. Summary

Block diagram of a possible configuration of a mobile distributed meteorological system



All connections 2-way via the Met Space.

Sample data flow using a networked Met-Space environment



Notes: (1) the Met Space Environment may be hosted in any available computing environment.
(2) MSA = Met Space Agent

UAV and UGV

PACBOT

Shadow UAV

Short-range UAV

Acoustic Sensor Test-bed

UAV Met Sensors: Old and New

The Metprobe: 1990 Technology

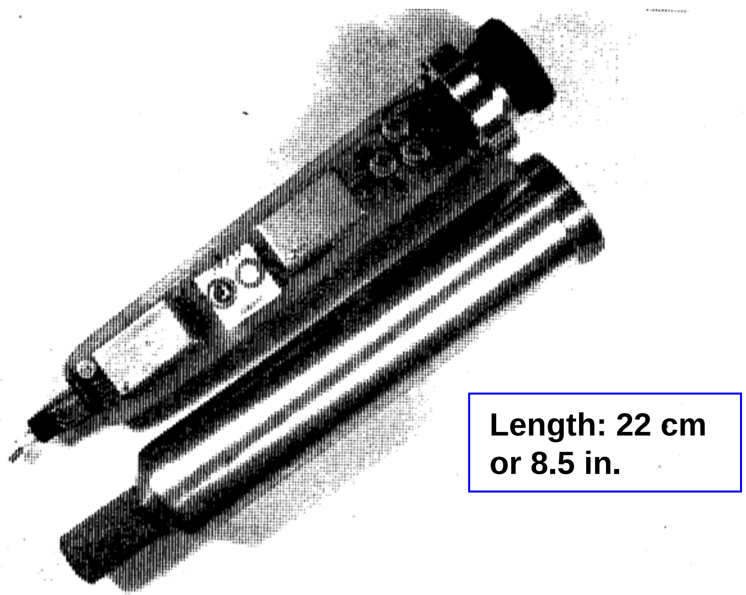
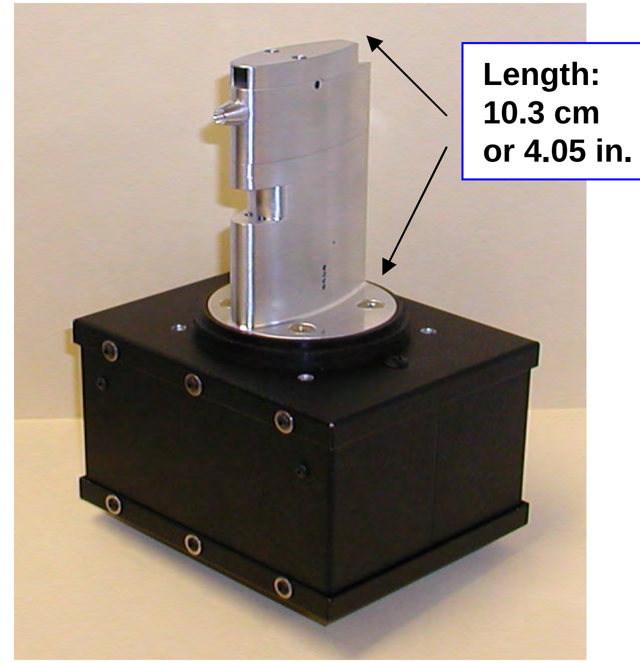


Figure 3. Single probe version of the metprobe. The hybrid chips contain about 90% of the electronics. The temperature and humidity sensors are located at the end of the probe within the filter, and the pressure sensor sits on the board between the hybrid chips.

The TAMDAR On-Board Weather Sensor System: 2005 Technology

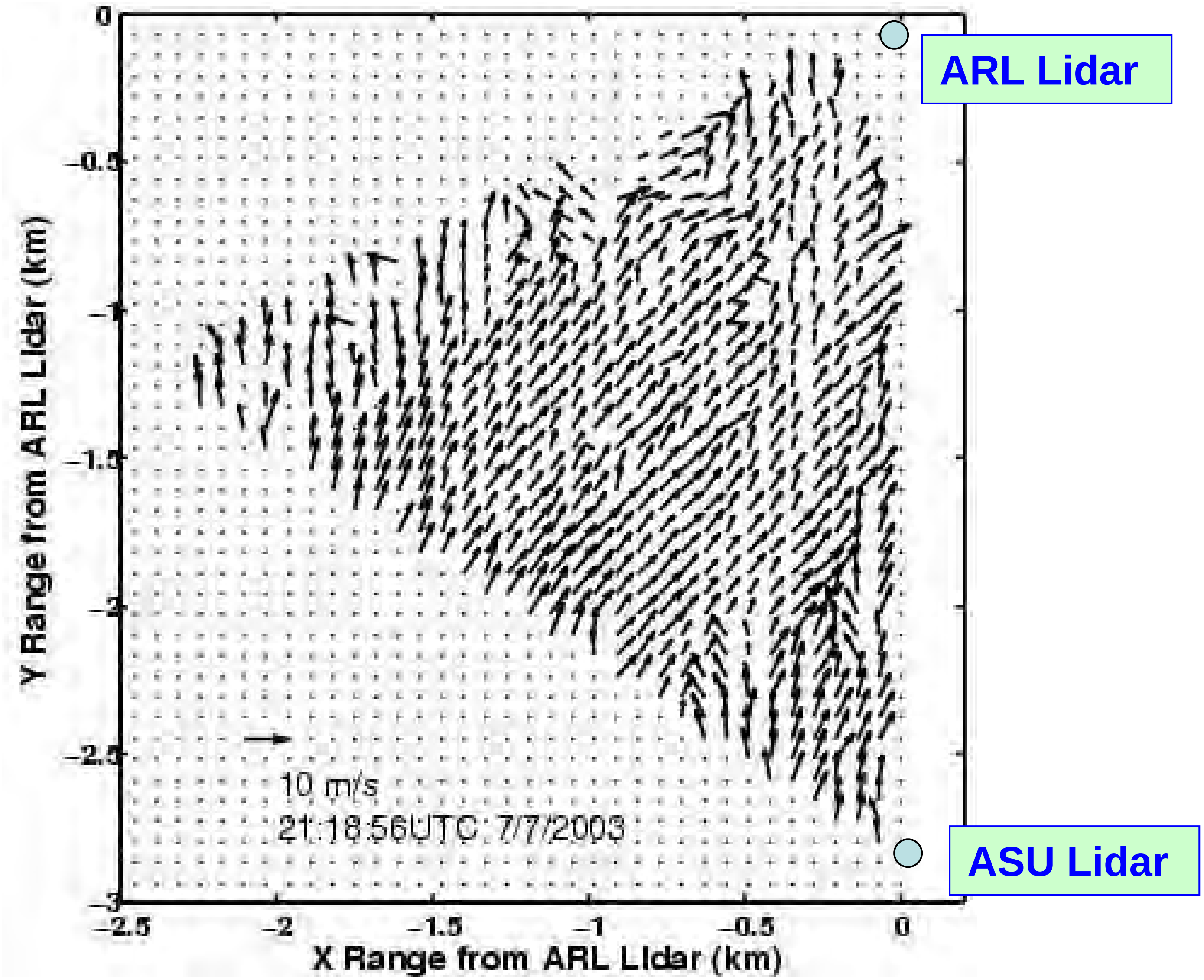


Detects and determines:

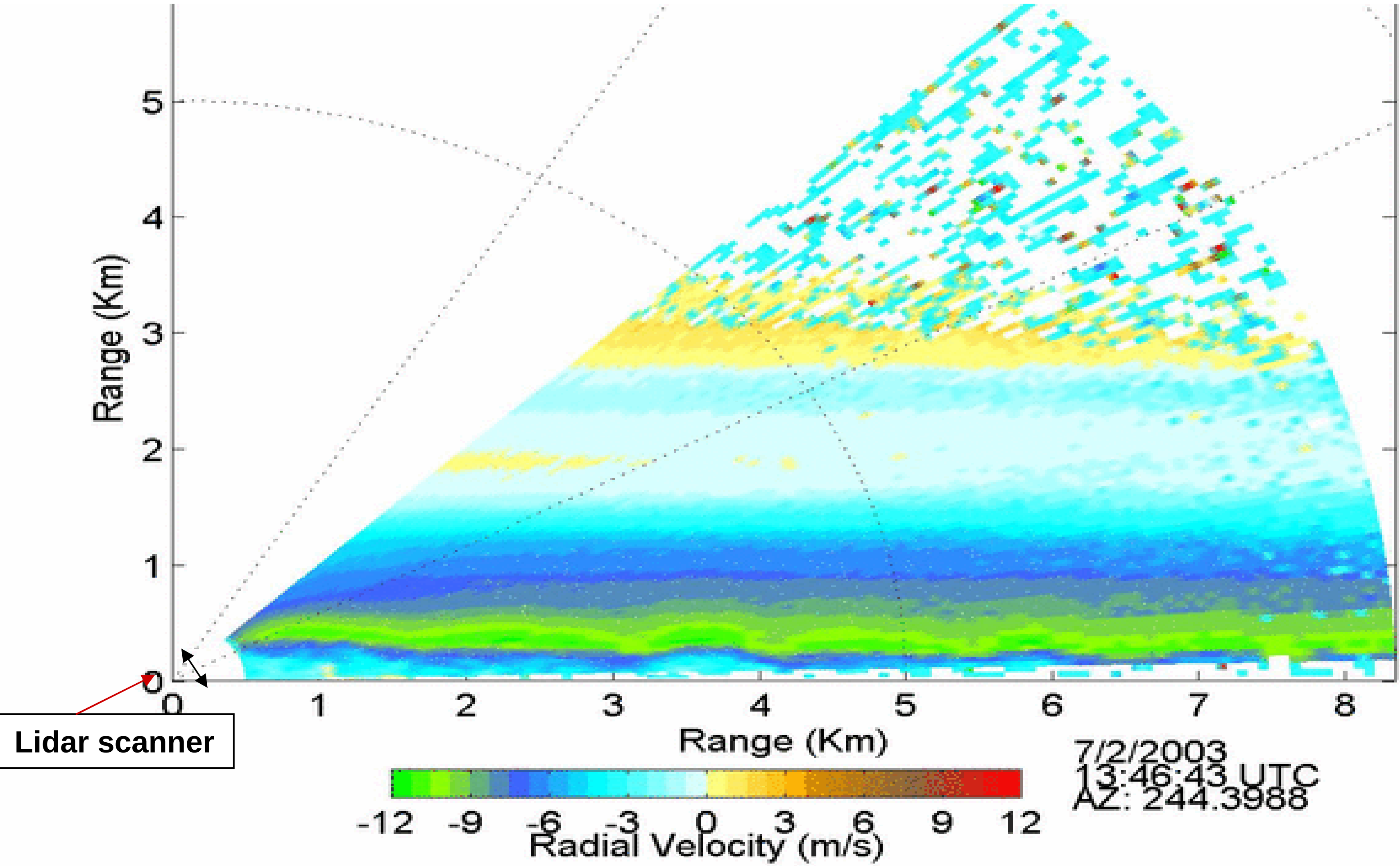
- Ice presence
- Median and peak turbulence
- Static pressure and pressure altitude
- Air temperature (Mach corrected)
- Relative humidity
- Indicated and true airspeed
- Wind speed and direction
- Built-in GPS

Future: Detection of atmospheric chem/bio/radiation presence.

Dual lidar winds south of OKC, July 2003



Boundary Layer Evolution at Oklahoma City under clear skies from the ARL Doppler Lidar



Wind From SW

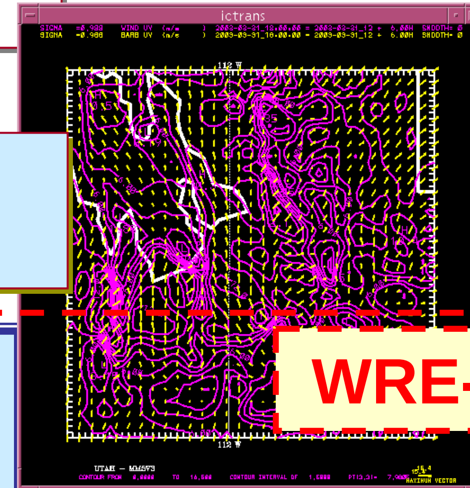
Weather Running Estimate – Nowcast (WRE-N)

The interactive combination of a rapid data assimilation and analysis tool with a fine resolution mesoscale short range prediction model.

Example: modified LAPS with WRF.

Hierarchy of models for high resolution updates to forecasts

Forecast - Operational Center (AFWA) Mesoscale MM5 Forecast for next 36-72 hours, 2-4 times daily, 45 to15 km resolution on a "global" domain

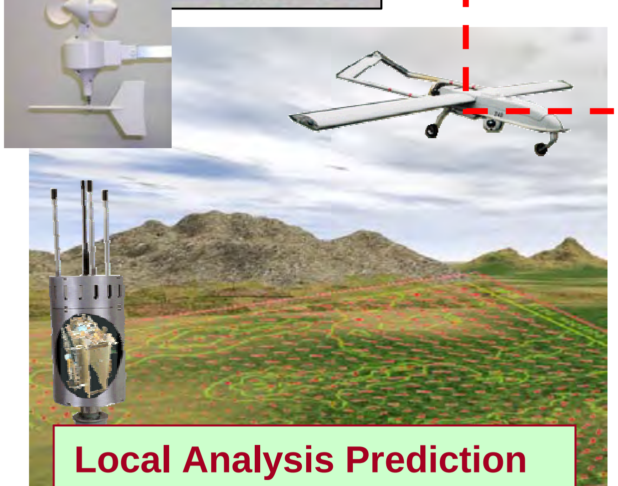


Local short term forecasts at BCT (IMETS/JET)

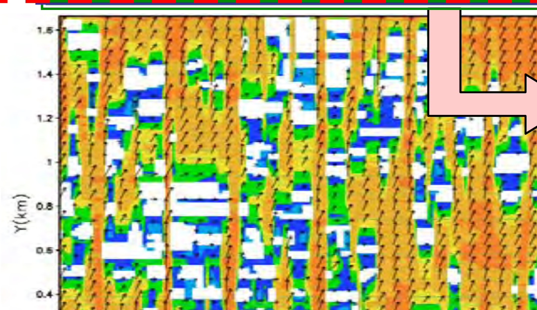
Nowcast (short term forecast) - run hourly, forecasting the next 3 hours on a 2.5 km grid over 150 x 150 km or smaller domains.

WRE-N

WRE (advanced local analysis) – run every 15-30 minutes on a 1 km grid over a domain within the Nowcast - Integrates local and non-conventional observations (METSAT, UAV sensor data, robotic wind sensors) into current nowcast – example: LAPS objective analysis in development at the University of North Dakota



Local Analysis Prediction System (LAPS) assimilates data at BCT (DCGS-A)



Diagnostic urban wind model running as embedded client on BCT DCGS / FCS

Diagnostic High Resolution Models – fast running (5-10 min) boundary layer wind model at 10-100 m resolution for complex and urban terrain effects on average wind flow – can use local observations

Provides input to advanced applications on DCGS-A.

Tactical Army WRE-N Strategy: Multi-component

WRE-N (BCT MM5 / WRF) Domain

~ 150 x 150 km

Runs every hour

Meso-gamma NWP with data assimilation – uses "hot start" method.

Nested WRE domain:

< 150 x 150 km

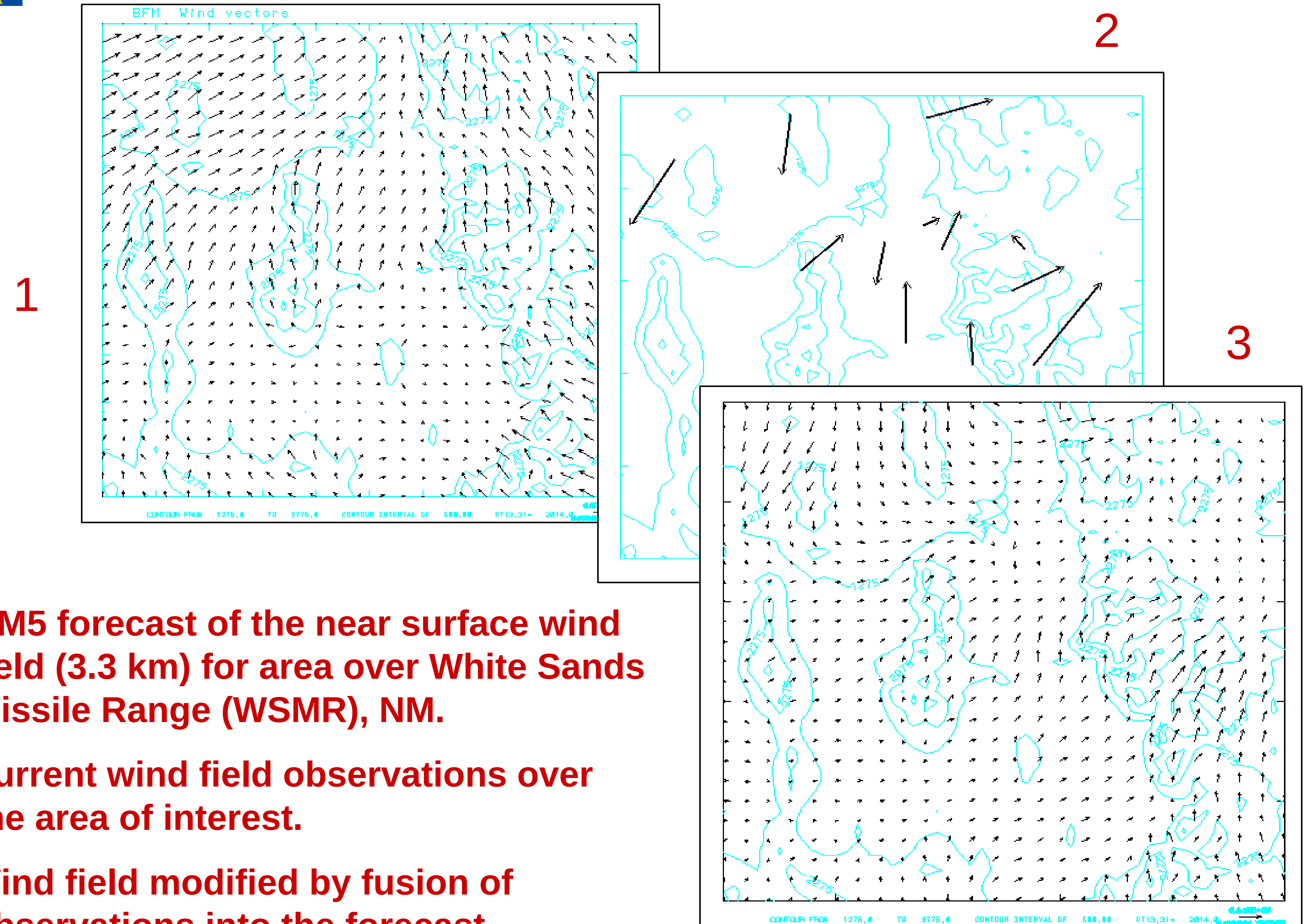
Objective analysis (e.g., modified LAPS, 4DDA)

Microscale model nested in WRE domain

Multiple nested WRE domains may lie within the WRE-N domain

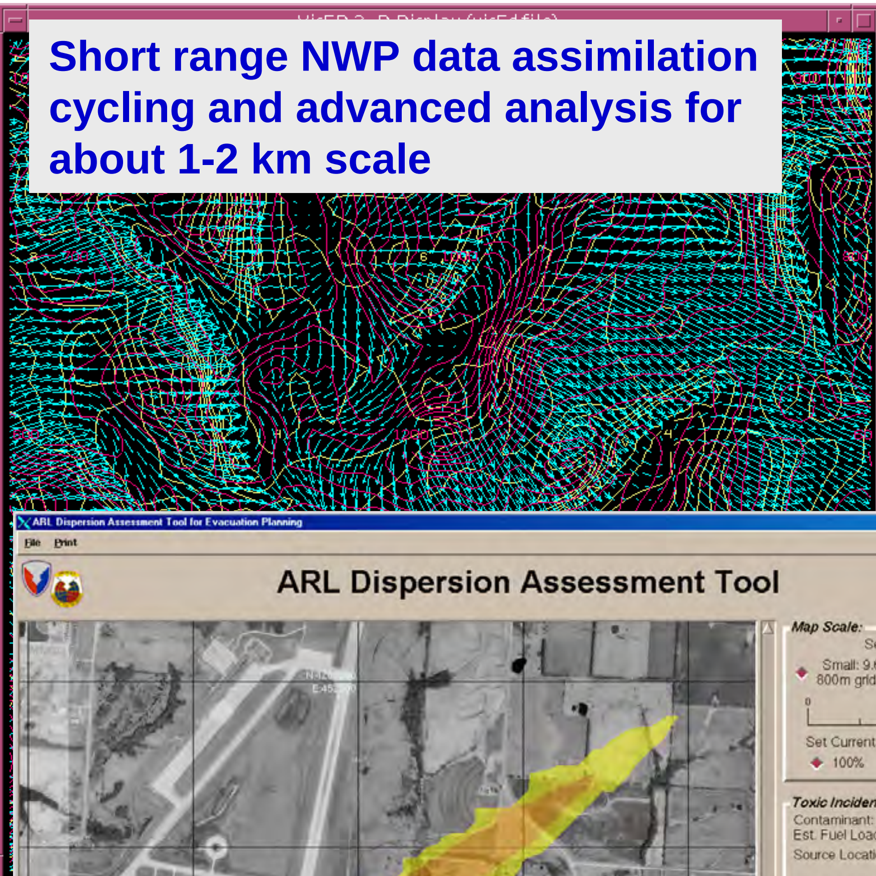
Microscale tools running on mobile platforms (e.g., PDA).

Modification of forecast using observations



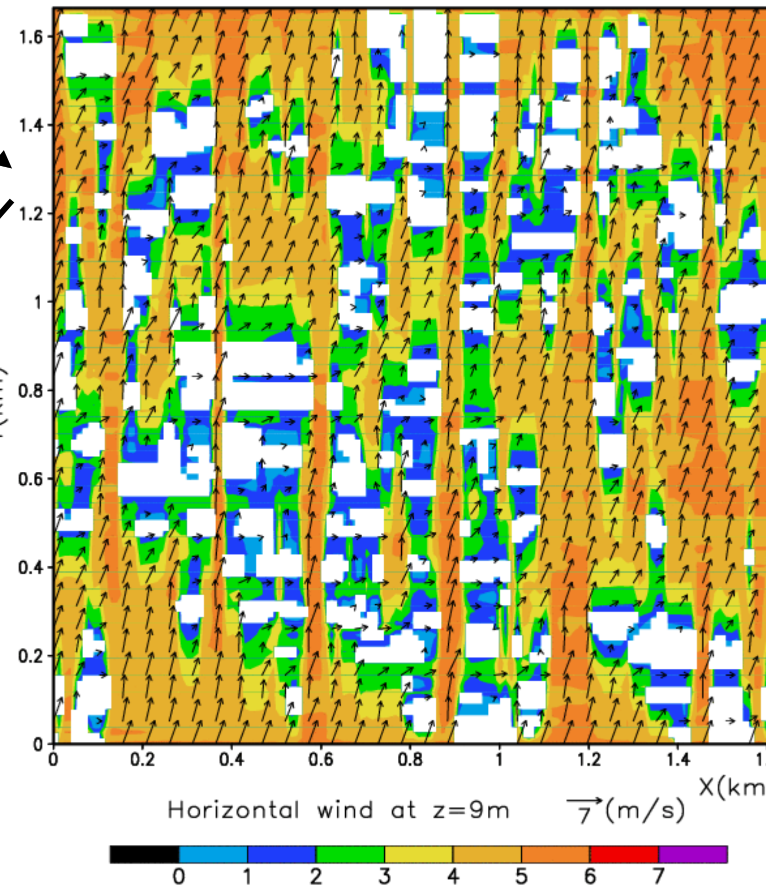
1. **MM5 forecast of the near surface wind field (3.3 km) for area over White Sands Missile Range (WSMR), NM.**
2. **Current wind field observations over the area of interest.**
3. **Wind field modified by fusion of observations into the forecast.**

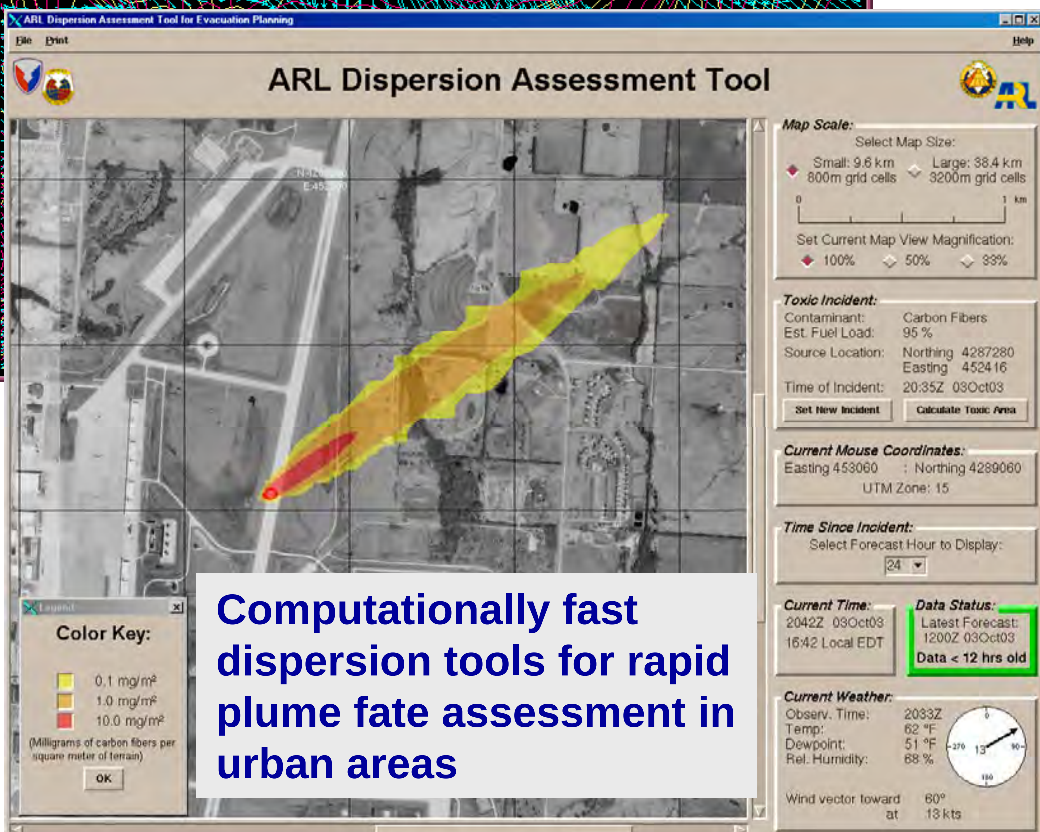
Hierarchal Meteorological Analysis "System" for Microscales



Short range NWP data assimilation cycling and advanced analysis for about 1-2 km scale

Computationally fast diagnostic micro and urban scale models to nest within the 1-2 km resolution analyses

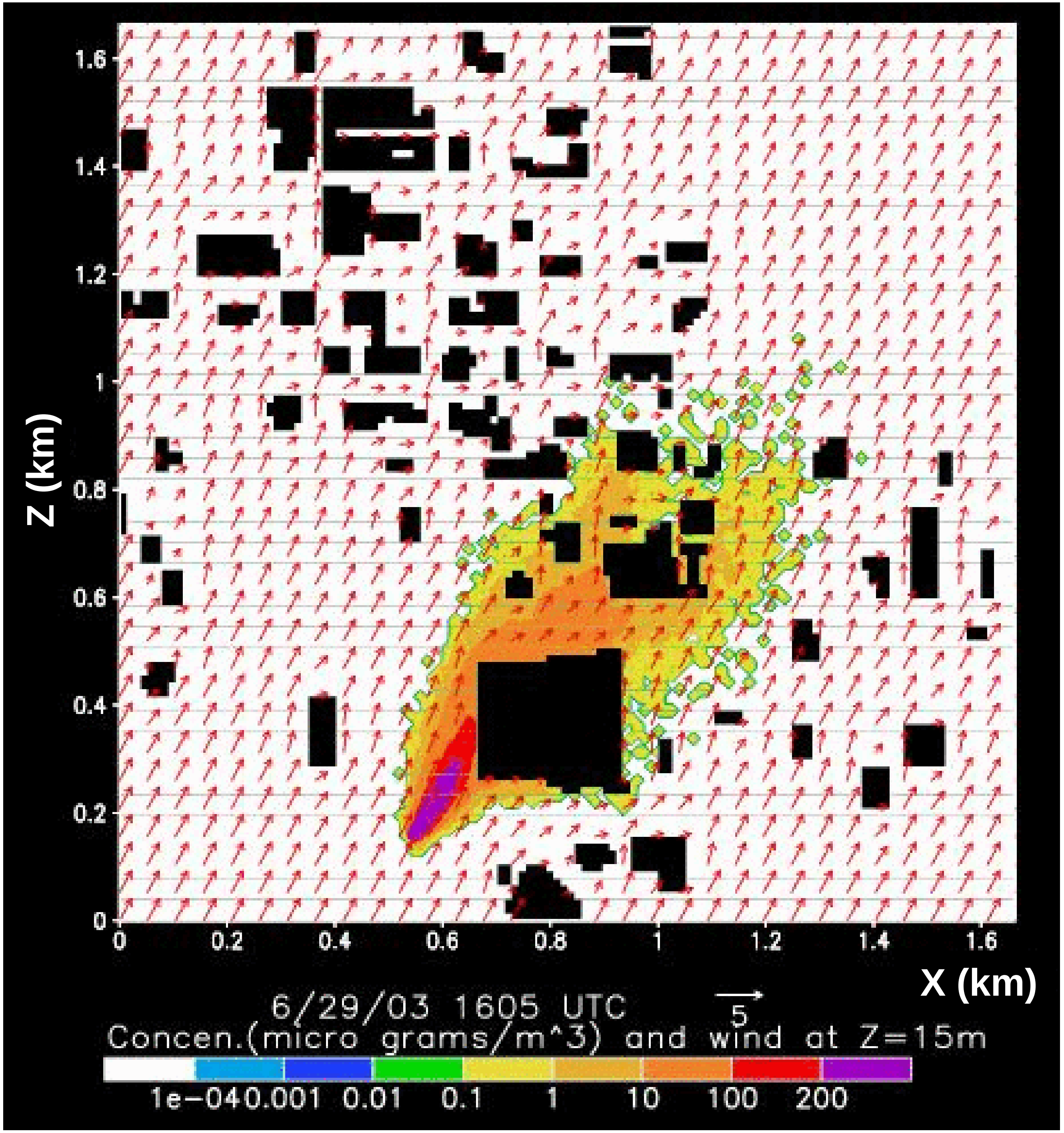




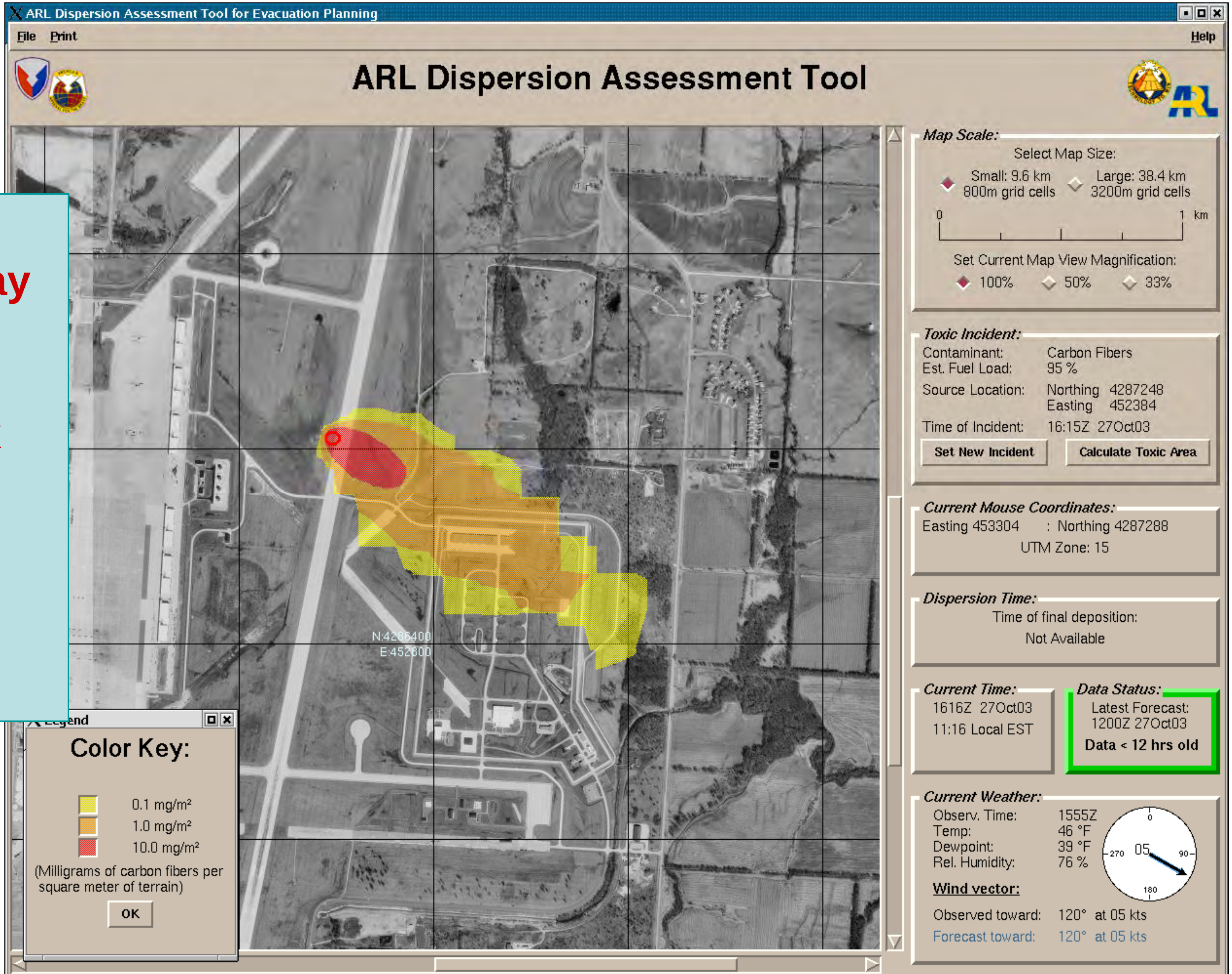
Computationally fast dispersion tools for rapid plume fate assessment in urban areas

Microscale analysis tools running on PDA platforms

3-D Wind Field (3DWF) with Lagrangian dispersion model showing change of dispersion with time over an urban area.

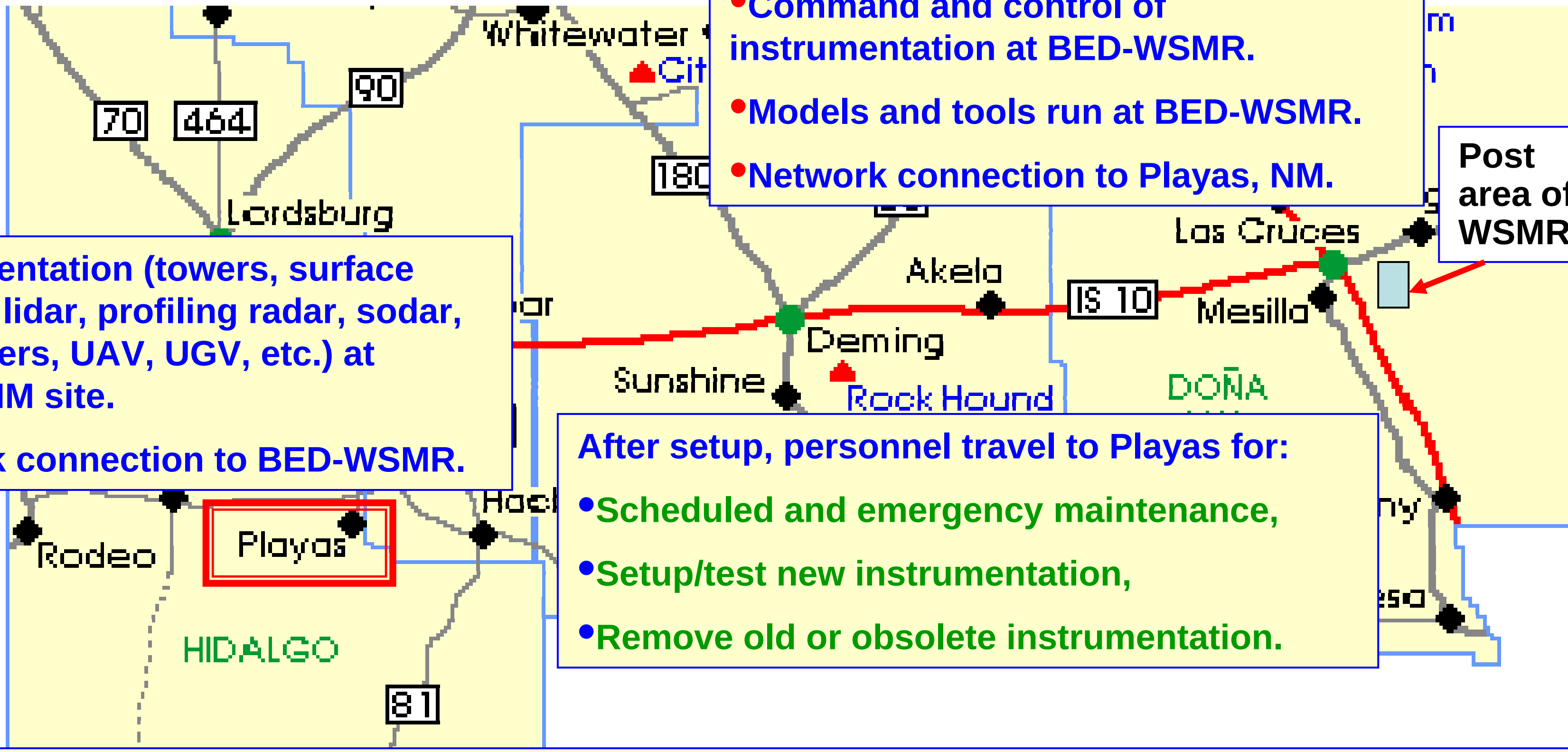


ARL DAT output display showing the deposition field after six hours following a release of hazardous material.



One concept of distributed operation (WSMR and Playas, NM)

- Command and control of instrumentation at BED-WSMR.
- Models and tools run at BED-WSMR.
- Network connection to Playas, NM.



- Instrumentation (towers, surface stations, lidar, profiling radar, sodar, radiometers, UAV, UGV, etc.) at Playas, NM site.
- Network connection to BED-WSMR.

After setup, personnel travel to Playas for:

- Scheduled and emergency maintenance,
- Setup/test new instrumentation,
- Remove old or obsolete instrumentation.

- Measurements feed analysis and forecast models in near real time.
- Analysis and model output, and user input, help determine instrumentation parameters (frequency of observations, data format, etc.). [Targeted observations.]
- New measurements provide near real time input to models that in turn help determine instrument parameters, ..., and so forth in a feedback loop.

CONTINUATION (Not the Conclusion)

- Proposal paper on work required to accomplish the goals of this presentation already prepared and available.
- Proposal paper on closely related work that would allow simulation of a distributed meteorological system using certain HPC facilities already prepared and available (not directly discussed in this presentation).

SUMMARY

1. A combined multi-model and sensor system can provide essential information on the state of the atmosphere and short term predictions for operations, CBNRE defense, and natural or man-made emergencies.
2. The system can serve as an R&D test-bed, a means for rapid testing of sensor or model prototypes, or as a local meteorological center.
3. The technology for such a system exists today and will not require a technological breakthrough.
4. The modular design allows the flexibility to handle the addition, subtraction, or replacement/upgrade of sensors, models, or other software with minimal disruption.

Health Effects Decision Support Tool for Civilian CB Air and Water Attack Scenarios

Presented by Dr. Shanna Collie
Toxicologist and Project Manager, Tetra Tech
NDIA S&T CBIS Conference

Albuquerque, NM ● 27 October 2005

Outline

- Impetus for chemical/biological (CB) preparedness in civilian settings
- Needs beyond *physical* and *logistical* readiness and response
- Differences in planning for a civilian CB incident response
- Overview and findings in 2005
- Opportunities for expansion, customization, and collaboration

CB Civilian Setting Preparedness

- Perspective via Threat and Consequence Assessment Division (TCAD) mission within EPA's National Homeland Security Research Center (NHSRC)
- Lessons learned since 2001: Recent popular press, SAB, and OMB assertions

These provide the impetus-- but not the specific path forward-- for execution of such a daunting task

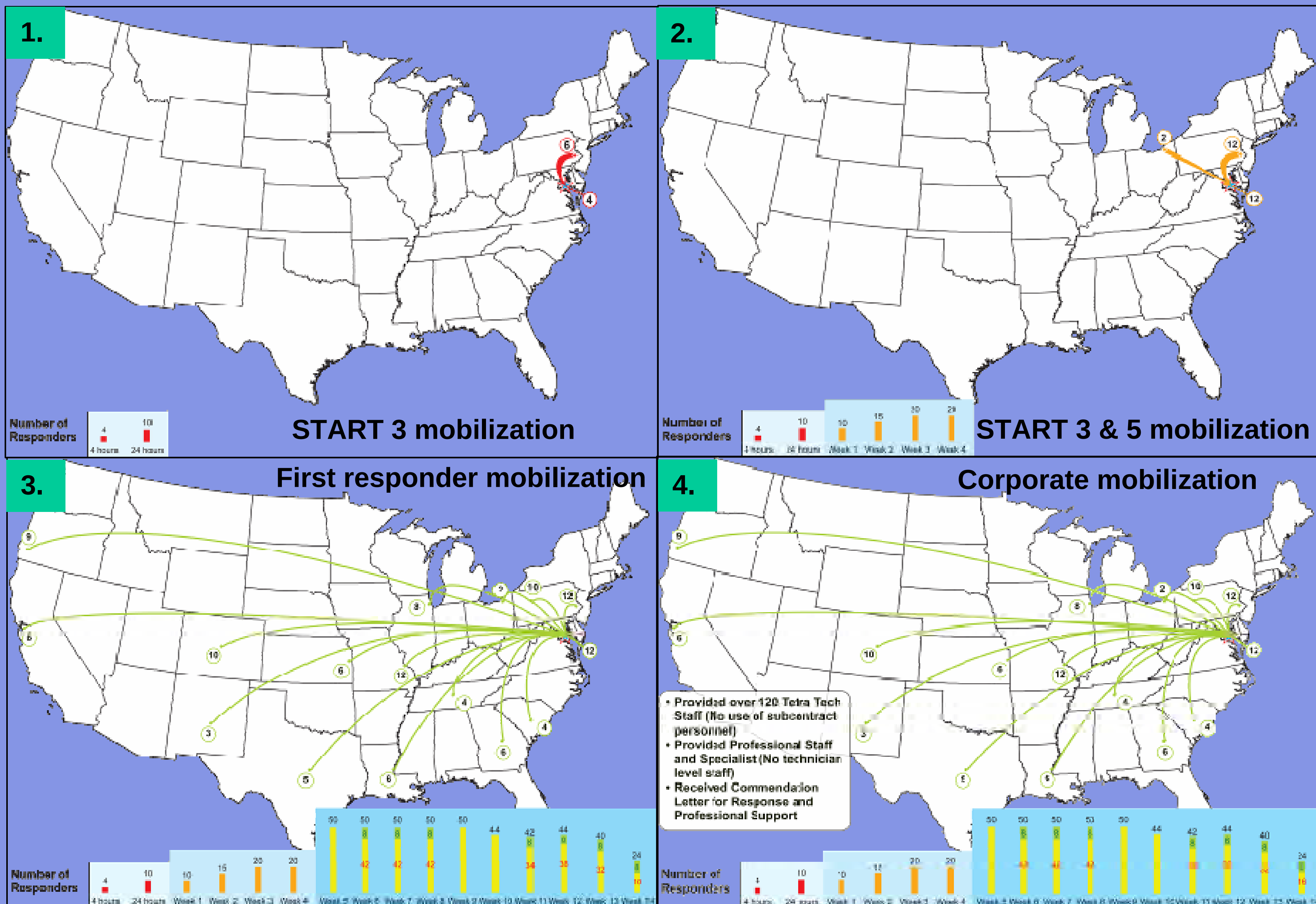
Lessons Learned: Capitol Hill

EPA called on Tt to provide support activities on Capitol Hill in response to the anthrax-contaminated mail found, including WMD Response; H&S Plan Development; Oversight/Documentation; Remediation and Isolation Design; Extent of Contamination Sampling; Data Management; PPE Level A/B/C Entries; and Sp. Ops.

Tt team at ClO_2 generator on 9th floor of Hart Building

Tt collecting surface wipe sample for anthrax

Anthrax National Response



START Experience

What Could It Take?

Beyond preparedness and training, we need--

- Sound scientific bases
- Rapid, transparent assessment
- Consistent, easily shared messages

To provide for these needs, EPA NHSRC created the ECAT:
Emergency Consequence Assessment Tool

What is Different in Civilian Setting?

What is the ***same***?

NEED ANSWERS FAST

(we don't have *weeks*)

What is **different?**

- Population composition
- Modeling environment
- Decision makers and drivers

The ECAT addresses these primary differences

ECAT Purpose, Scope, and Goals

- Purpose: To enable pre-emergency planning for ***rapid and consistent*** response and risk assessment
  - Can be pre-programmed at the regional or local level
  - Intended to be flexible rather than prescriptive
  - Customize models, calculations, and specifications beforehand
- Scope: Pilot addressing 10 scenarios in a secure web-based platform for ease of access, flexibility, and utility
- Goals: To design ECAT to be scaled up without investment in reprogramming and exceed functional specs

ECAT Users, Designers, and Testers

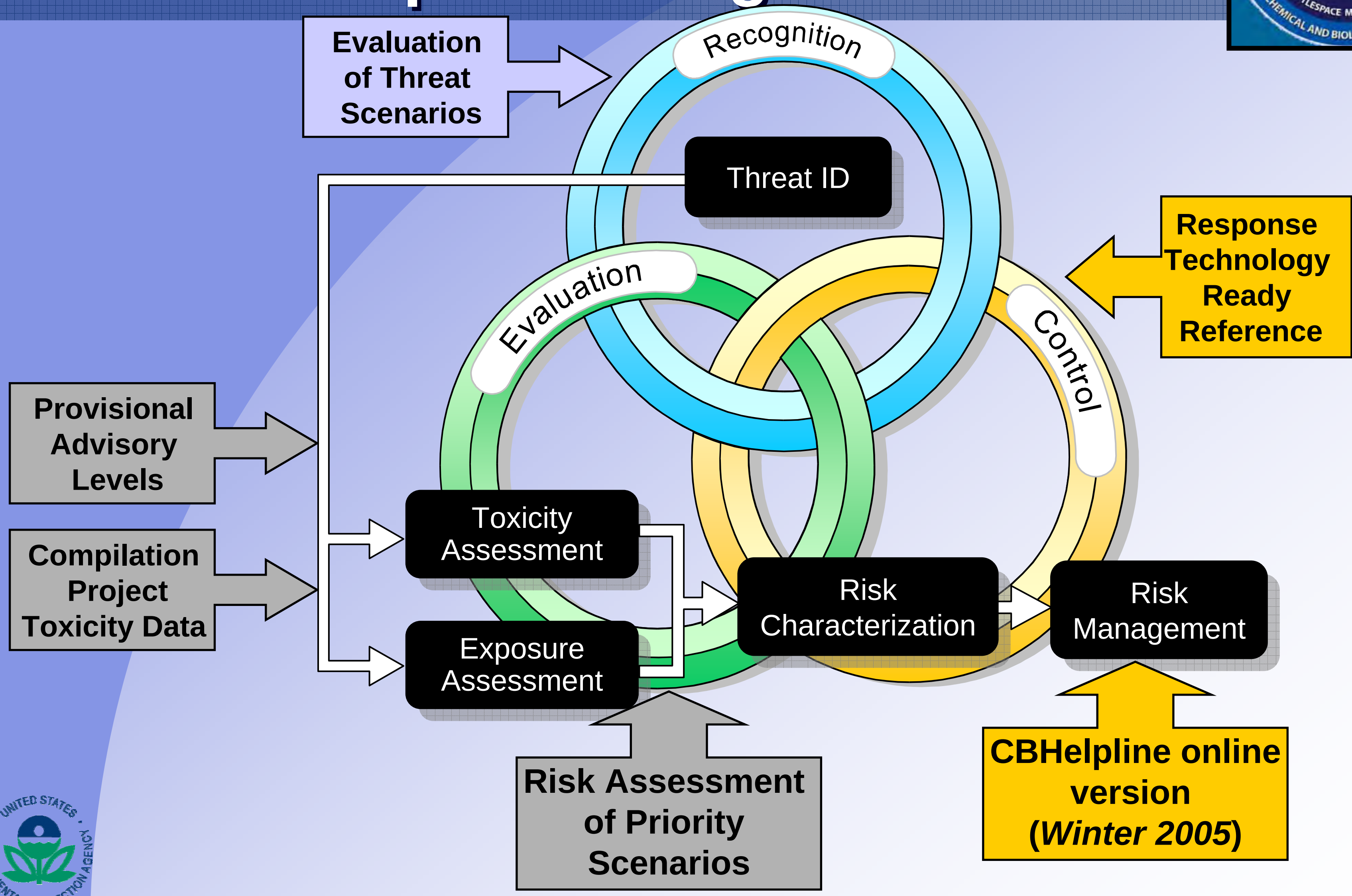
Potential Users

- On-scene coordinators, responders, and science advisors
- Emergency planners and trainers
- Decision makers, administration, and management

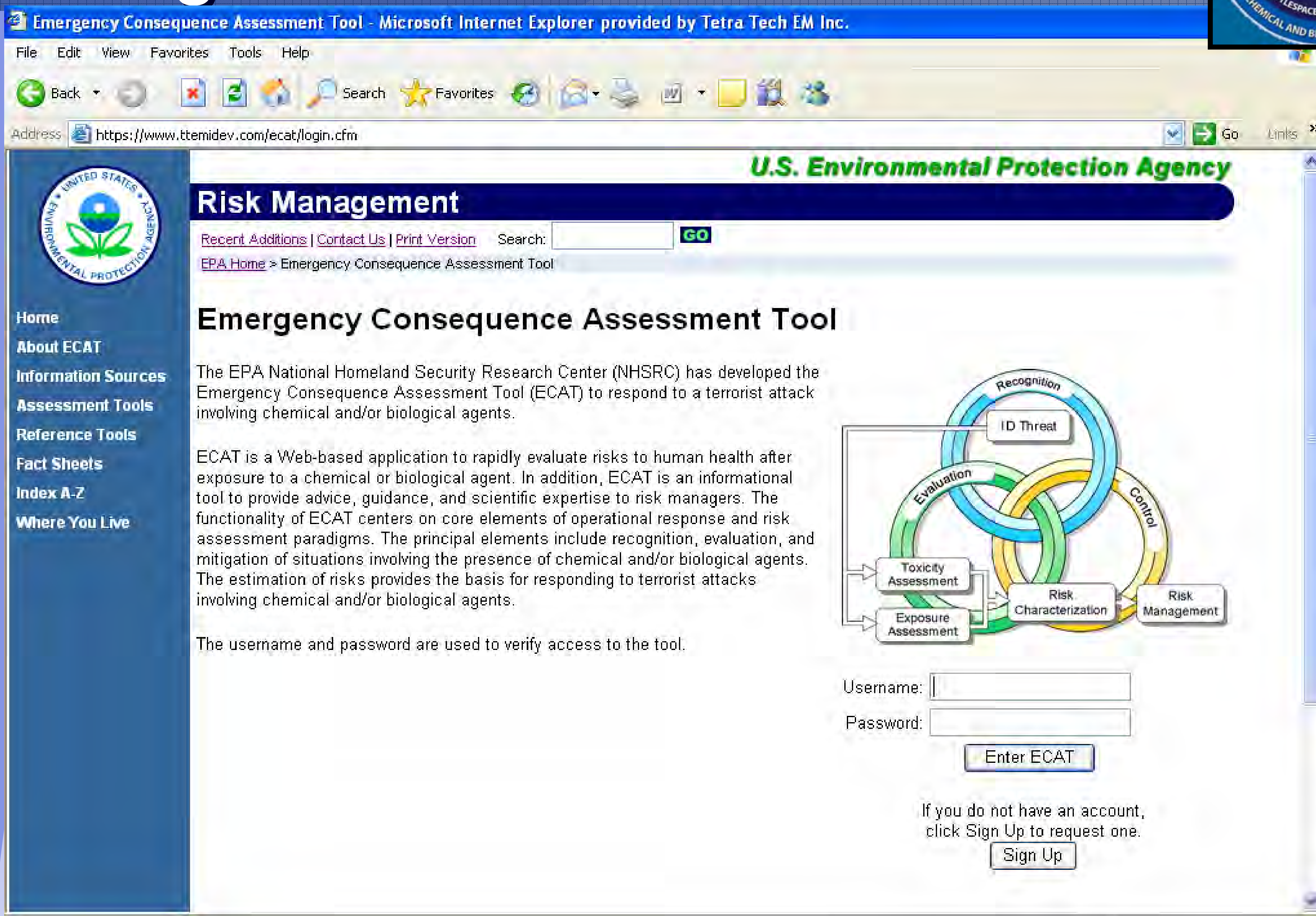
Designers and Beta Testers

- First responders and technical experts (toxicology, models)
- 37 EPA personnel including scientists and OSCs beta tested Version 1.0 in May 2005
- 8 additional testers commented on Version 2.0 in September 2005

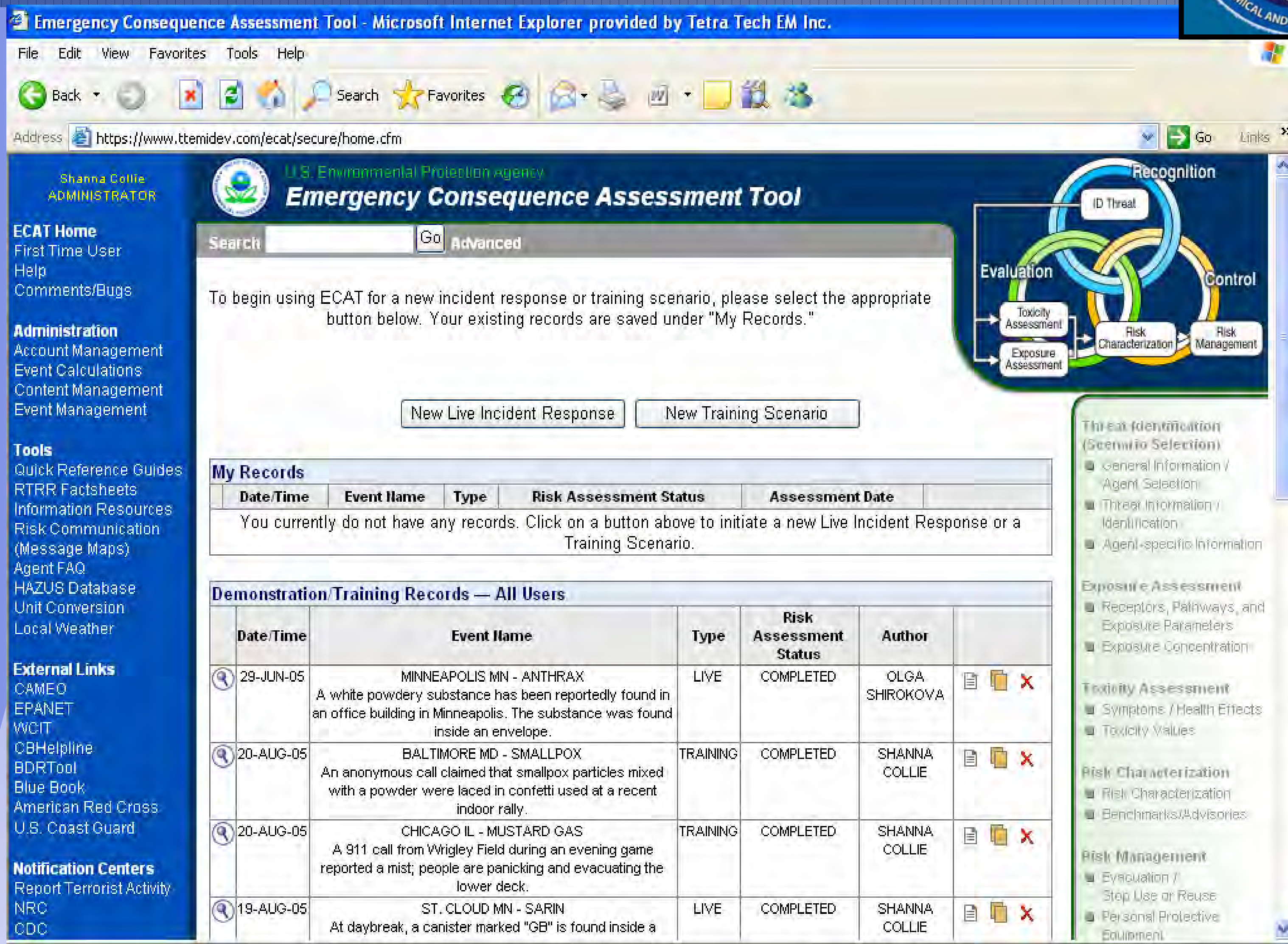
ECAT Conceptual Design



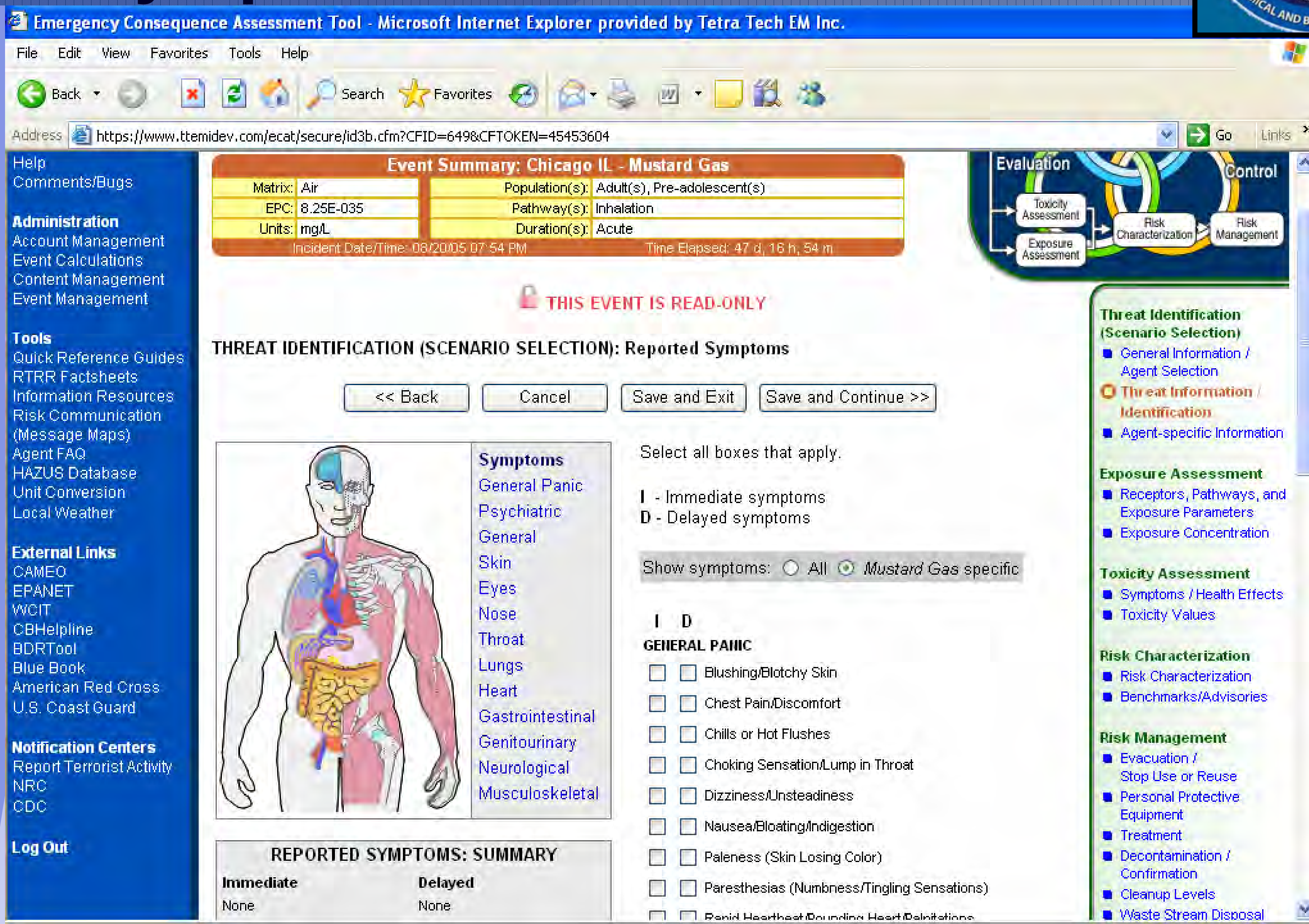
ECAT Login Screen



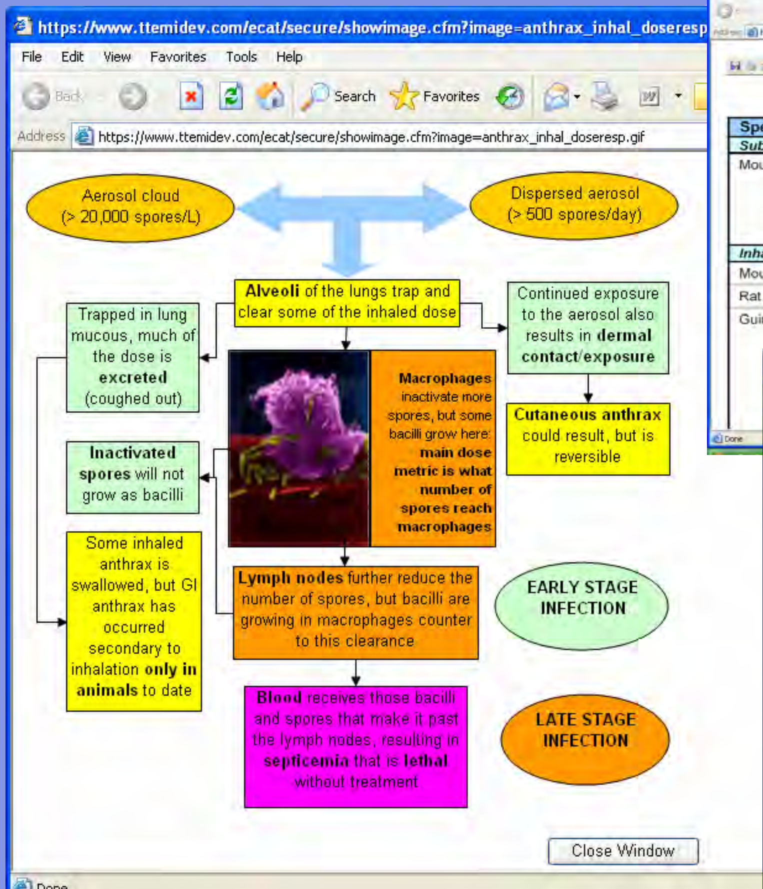
ECAT Command Screen

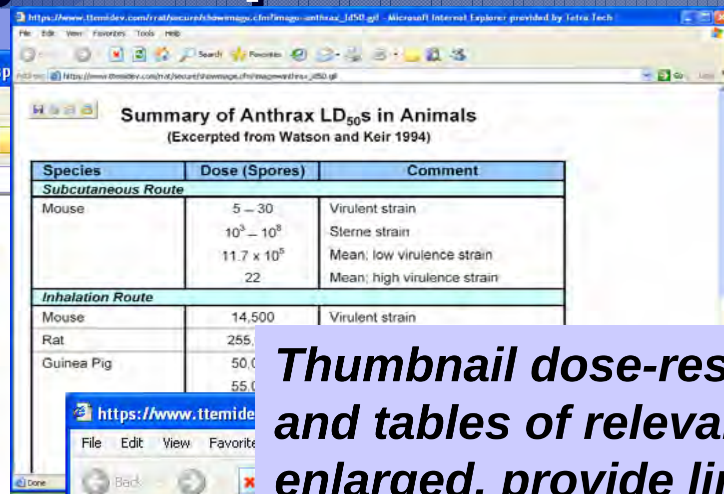


ECAT Symptom Match



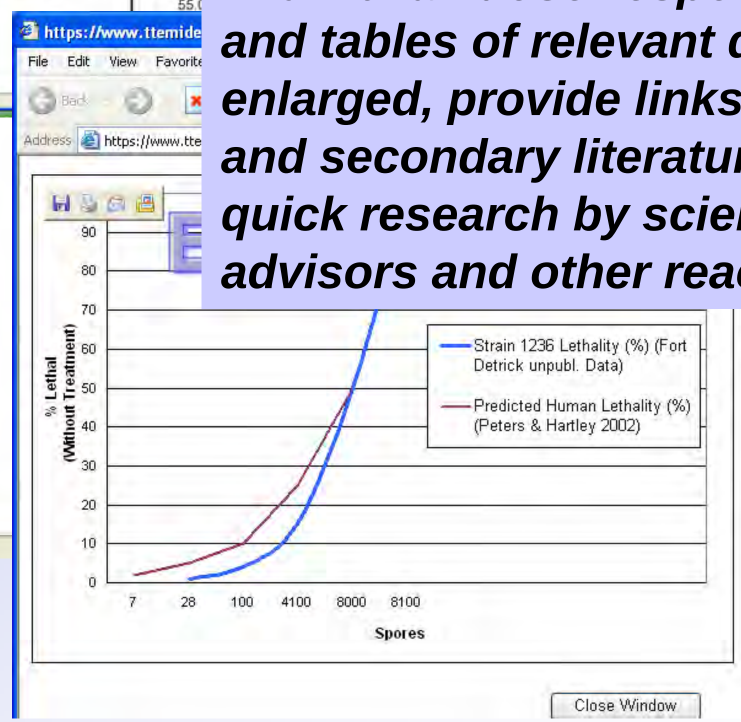
Biothreat Infectivity Compilation





Summary of Anthrax LD_{50}s in Animals
(Excerpted from Watson and Keir 1994)

Species	Dose (Spores)	Comment
Subcutaneous Route		
Mouse	5 – 30	Virulent strain
	$10^3 – 10^8$	Sterne strain
	11.7×10^5	Mean; low virulence strain
	22	Mean; high virulence strain
Inhalation Route		
Mouse	14,500	Virulent strain
Rat	255,[illegible]	
Guinea Pig	50,[illegible]	
	55,[illegible]	



Thumbnail dose-response curves and tables of relevant data, when enlarged, provide links to primary and secondary literature: enables quick research by science advisors and other reachback staff

Key Findings Overview

- Exposure and Toxicity Assessments
  - Each chemical & biological threat agent is different
  - Traditional chronic assessments are less relevant
  - Special assessments are generally not needed
  - Assumptions other than chronic are widely varied

- Risk Characterization and Management
  - MID opposition and biological quantification exceedingly difficult
  - Critical effect may be different than in chronic predictions
  - Collaboration comes with a cost
  - Policy decisions essential for every recommendation

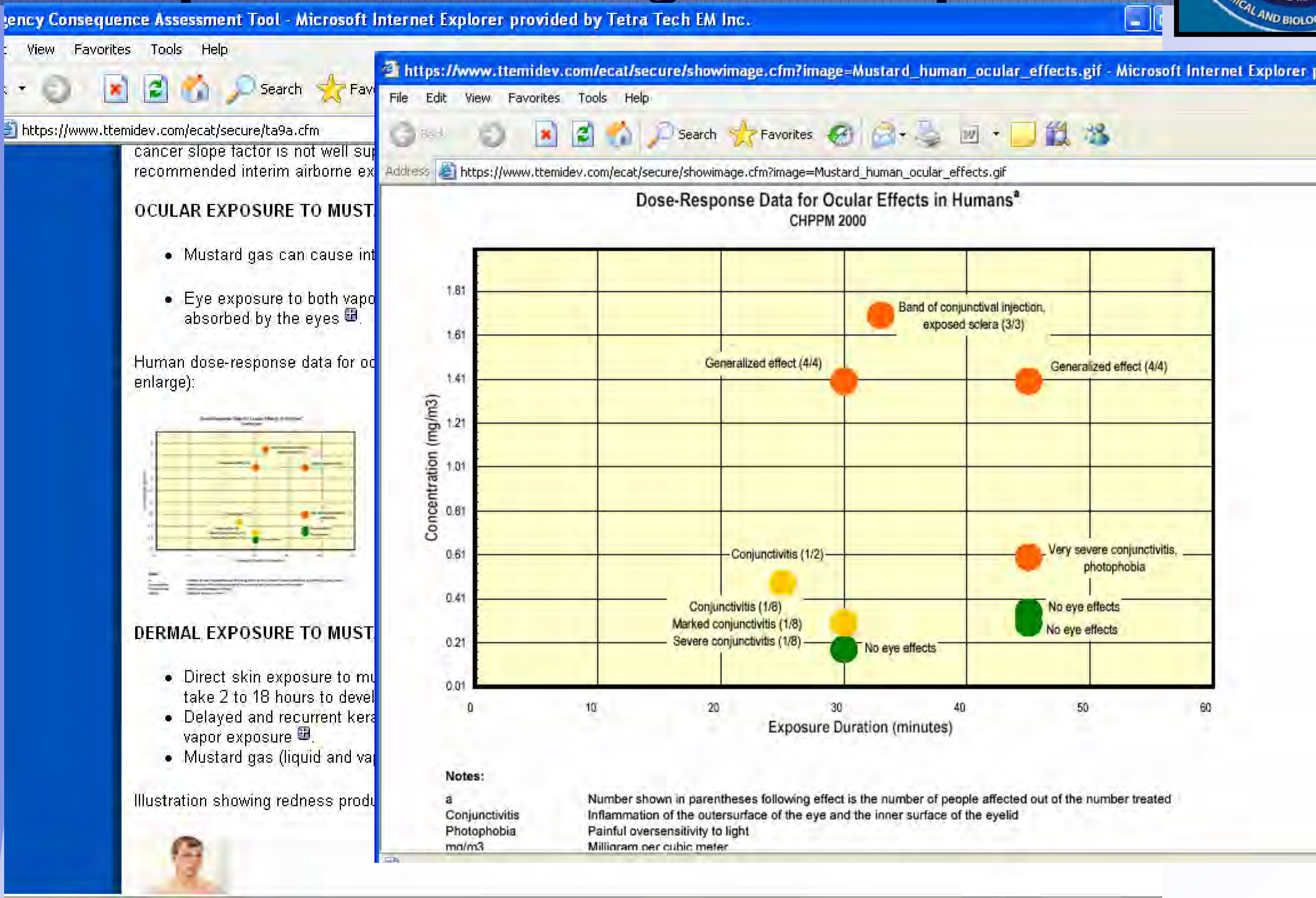
The ECAT addresses an interim proposed approach that will evolve during peer and policy review.

Exposure & Toxicity Findings

- Each chemical threat is different (parathion vs. GB vs. VX)
- Each biological threat is different (bacteria, viruses, spores)
- Traditional chronic exposure assessment methods are of more limited value
- Special assessments generally not needed for acute/short term minor pathways
- Assumptions other than chronic are widely varied

Specific examples follow …

ECAT Exposure Findings Example



ECAT Toxicity Findings Example

Emergency Consequence Assessment Tool - Microsoft Internet Explorer provided by Tetra Tech EM Inc.

Responsive to an NHSRC comment on a prototype demo of the ECAT on April 28, the option to customize a reference dose was added. At this time, studies previously reviewed by ATSDR and other secondary sources are shown here to give the look and feel of how the function could work. Therefore, no new criteria for selection or appropriateness of an underlying primary study have been applied by the ECAT developers. Additional studies may be available and/or may be identified for use in future versions. Other studies may be available but may have been determined by ATSDR or others not to have been of sufficient scientific rigor to be tabulated in their toxicological profiles. While the data shown themselves are accurate, the inclusion or exclusion of studies on this table in Version 1.0 of the ECAT does not indicate the expanse or quality of the toxicological database for the threat agent.

SELECT TOXICITY VALUES

Pathway: *Inhalation* **RfD Type:** *Acute (Up to 1 day)*

	Agent	Species	Route	Duration	Freq.	Target Organ	Effects	Values	Ref.
1.	Mustard Gas	Human		33 min		Eyes	Injection band over sclera	**LOAEL:** 0.486 mg/kg-day	
2.	Mustard Gas	Mouse		60 min		Respiratory System	RD50	**LOAEL:** 0.08 mg/kg-day	
3.	Mustard Gas	Human		15 min		Eyes	Conjunctival injection	**LOAEL:** 0.03 mg/kg-day	
4.	Mustard Gas	Human		10 min		Eyes		**NOAEL:** 0.03 mg/kg-day	
5.	Mustard Gas	Mouse		60 min		Renal	Increased blood and urine uric acid levels	**LOAEL:** 6.09 mg/kg-day	
6.	Mustard Gas	Mouse		60 min		Respiratory System	Decreased Respiratory Frequency	**LOAEL:** 6.09 mg/kg-day **NOAEL:** 4.83 mg/kg-day	

Uncertainty Factor: -- Select Uncertainty Factor --

Select Cancel

Done Internet

Characterization & Mgmt Findings

- MID opposition and biological quantification exceedingly difficult
- Critical effect may be different than in chronic predictions (e.g., noncancer vs. cancer), in turn affecting management of risk
- Collaboration downside
- Policy and legal reviews

The ECAT interim approach will continue to evolve during subsequent peer and policy reviews

ECAT Infectivity Findings Examples

Emergency Consequence Assessment Tool - Microsoft Internet Explorer provided by Tetra Tech EM Inc.

File Edit View Favorites Tools Help

Back Search Favorites

Address https://www.ttemidev.com/ecat/secure/rc10ab.cfm Go Links

CBHelpline
BDRTool
Blue Book
American Red Cross
U.S. Coast Guard

Notification Centers
Report Terrorist Activity
NRC
CDC

Log Out

	Receptor	Pathway	EPC (cfu/L)	Contact Rate (L/d)	RfD	HI
1.	Teenager	Ingestion	800	0.75	10 organisms	60
2.	Adult	Ingestion	800	1	10 organisms	80

DEFINITION OF RfD AND HI IN A BIOLOGICAL CONTEXT

At the present time, because microbial risk assessment methods are still under development and review, classic EPA terminology borrowed from a chemical context and the Risk Assessment Guidance for Superfund is adapted to give a semiquantitative measure of potential for infection based on minimum infectious doses (MID) reported in the literature.

The MID is used as a "reference dose" (RfD) for a conservative number of organisms that may cause infection. The likelihood of infection is reported as the ratio of the calculated exposure (number of organisms per day) to the MID (RfD). This likelihood of infection is a biological infection "hazard index" (HI). This system is not perfect and is a gross estimate of one "worst-case" estimate based on the infectious dose noted as the RfD. The basis of the RfD can be determined by clicking the hyperlink above, and an alternate RfD can be selected if a different infective dose is desired.

NOTES ON INFECTIOUS DOSE (ID) ASSUMPTIONS

The American Biological Safety Association (ABSA) reviewed the concept of the "infectious dose" in 2003 on behalf of OSHA. Findings of the ABSA as of 2003 included the following cautions:

- ABSA concluded ID values developed using past studies would not be accurate, in large part due to the "lack of a clear and universally acceptable definition of the term ID"
- Animal testing is not standardized (making comparisons difficult), extrapolation to humans is unreliable, and inbred animal strains do not represent "outbred" humans
- ID is affected by many other conditions, such as condition of the host, genetics, and previous (potentially immunity-granting) exposure
- Bacteria within a species vary widely in virulence and ID, making generalizations about the ID of a species impossible.

For these and other reasons set forth by the ABSA-OSHA Alliance, the user is cautioned that ID-based estimates are highly uncertain. To view the ABSA position on ID, click here.

Risk Characterization
- Risk Characterization
- Benchmarks/Advisories

Risk Management
- Evacuation / Stop Use or Reuse
- Personal Protective Equipment
- Treatment
- Decontamination / Confirmation
- Cleanup Levels
- Waste Stream Disposal Options
- Detection Methods

Opportunities Relevant to NDIA

- Expansion
  - Natural disaster recovery and assessment
  - PR and legal reviews for risk communication
- Collaboration
  - DC DOD-EPA liaison
  - Small business partnerships
- Customization
  - Aircraft interiors and shipboard applications
  - OCONUS planning for urban landscape/int'l aid

Possibilities are nearly unlimited

Acknowledgements and Contact

- Grateful for funding by EPA NHSRC TCAD
- Appreciate beta testing comments and time commitment by EPA
- Impossible without contributions by contractor team and DOE

… and to you, for your time and attention today.

- Kevin Garrahan, PhD, PE
  EPA NHSRC TCAD Task Order Manager
  garrahan.kevin@epa.gov : phone 202-564-3336

- Shanna Collie, PhD
  Tetra Tech (Contractor) Toxicologist & Project Manager
  shanna.collie@ttemi.com : phone 830-537-5565

http://www.epa.gov/nhsrc/pubs/fsECAT083005.pdf

https://www.ttemidev.com/ecat/login.cfm

Combined Defense

Science and Technology for Chem-Bio Information Systems

25-28 October 2005

Keith Gardner
Northrop Grumman IT

Combined Defense

- The combined defense of a fixed-installation involves the combination of many different assets to be effective.
- The decision maker may choose to substitute one type of defensive measure for another (*e.g.* guards instead of fences).
- Analysis of this problem should take the form of a portfolio analysis- minimizing risk while conforming to a certain level of investment.
- The underlying requirements for this approach are that each element has a particular cost and associated value (based on expected return or effectiveness). Preliminary results are **value** only.

Logical Decisions Combined Defense Model

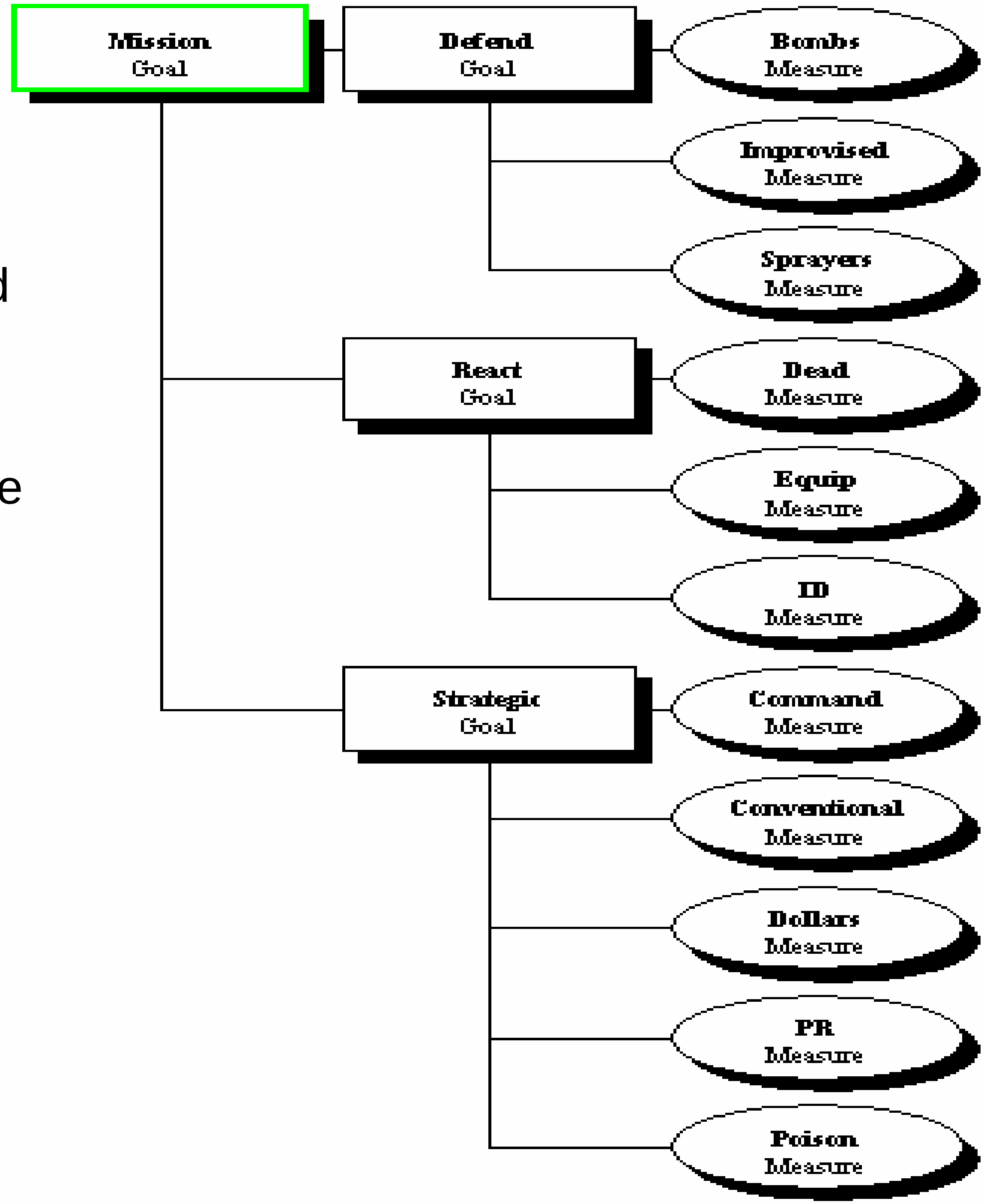
- A file was created in the LDW program by the DTRA OR cell which includes the defensive measures a base can take, the types of attacks it may need to defend against, and the goals it may need to achieve.
- Experts provided input values for the effectiveness of every action in relation to every attack or goal of the mission.
- This program can be used by a decision maker to find which actions should be taken in order to best achieve the overall goal.
- The decision maker can alter the inputs to reflect his changing concerns and objectives by altering the weights held by the many actions, values and goals.

Procedure for Decision Analysis

- Brainstorming to enhance the universe of possibilities for variables and alternatives which may be considered in the model
- Consolidation of the variables into an exhaustive and exclusive list of the pertinent variables
- Construction of the relationships between the variables and outcomes
- Gathering of data for the measures involving the mix of expert opinion, research and experimentation to gather inputs for the model
- Assignment of relative weights for the overall goals (mission, deaths, cost)
- Sensitivity analysis to determine tipping points (solution changes based on weight) for borderline evaluations
- Final determination of relative values of the inputs
- Normalization to reflect physical results

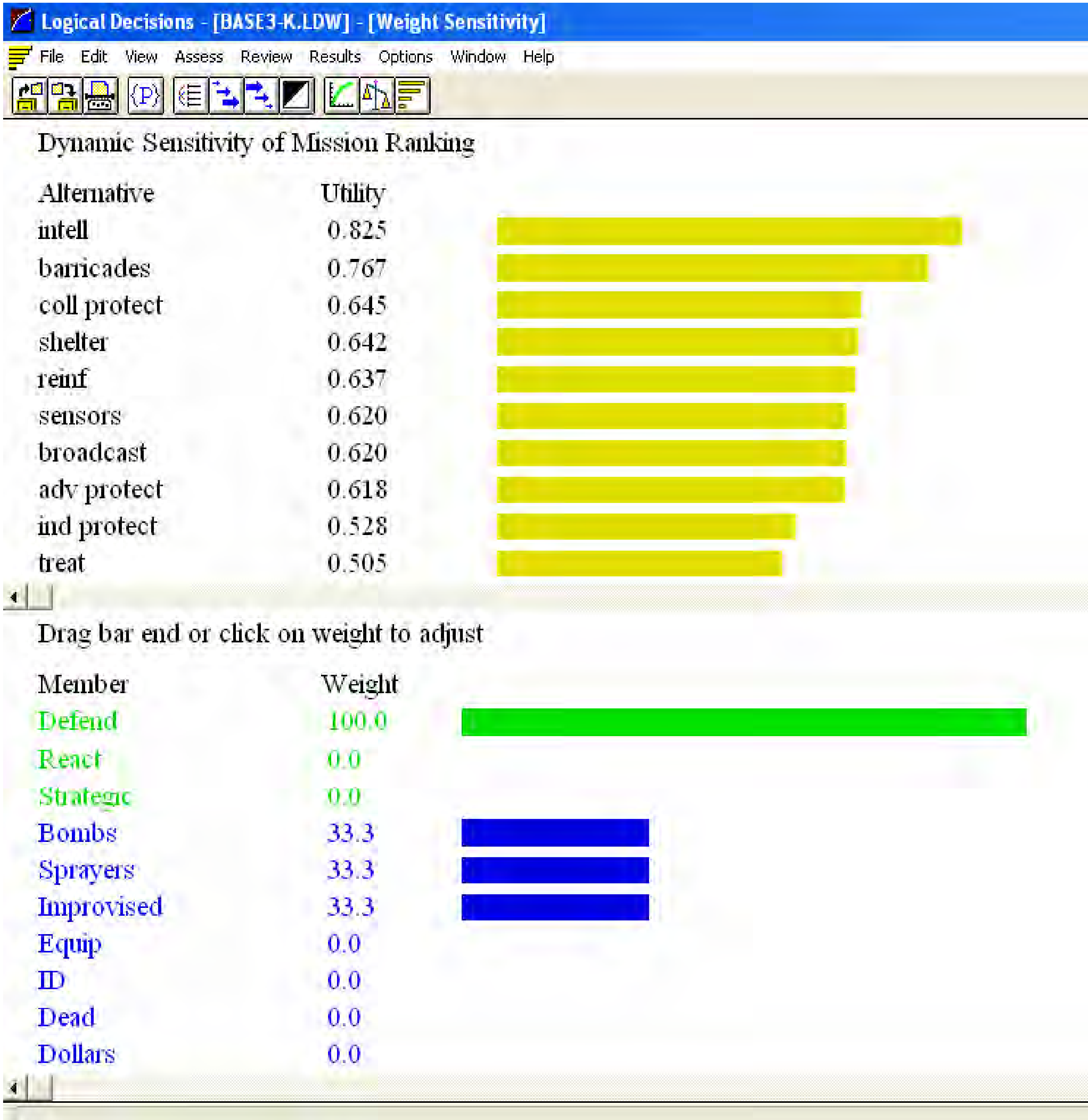
Goals Hierarchy

- The measures are categorized into three goals: defend, react, and strategic
- These three goals are all aimed at achieving the overall goal of the mission
- It is assumed that the mission is the absolute objective, and that sacrifices of personnel and equipment will be made in order to preserve and continue the mission

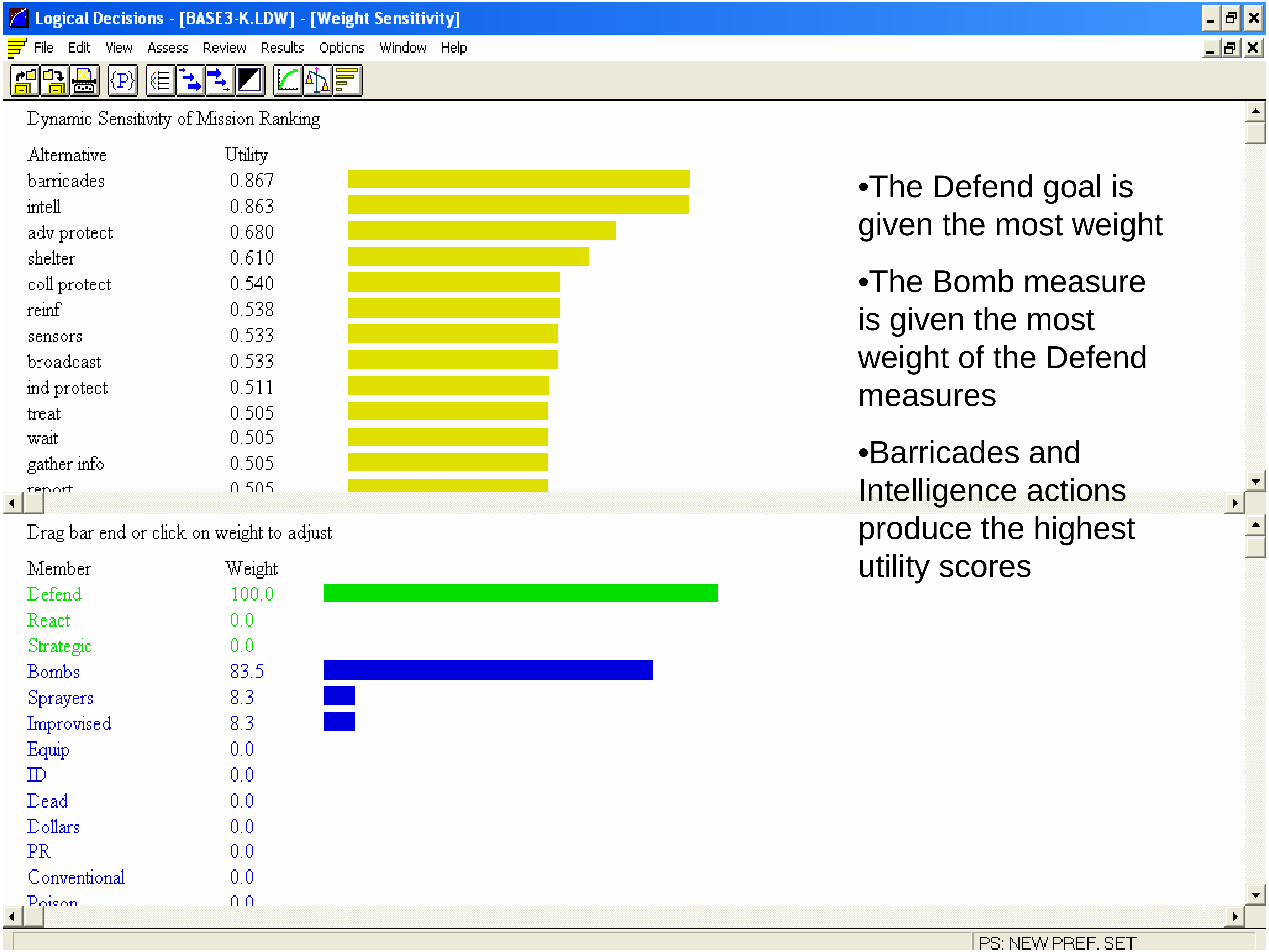


Matrix of Inputs

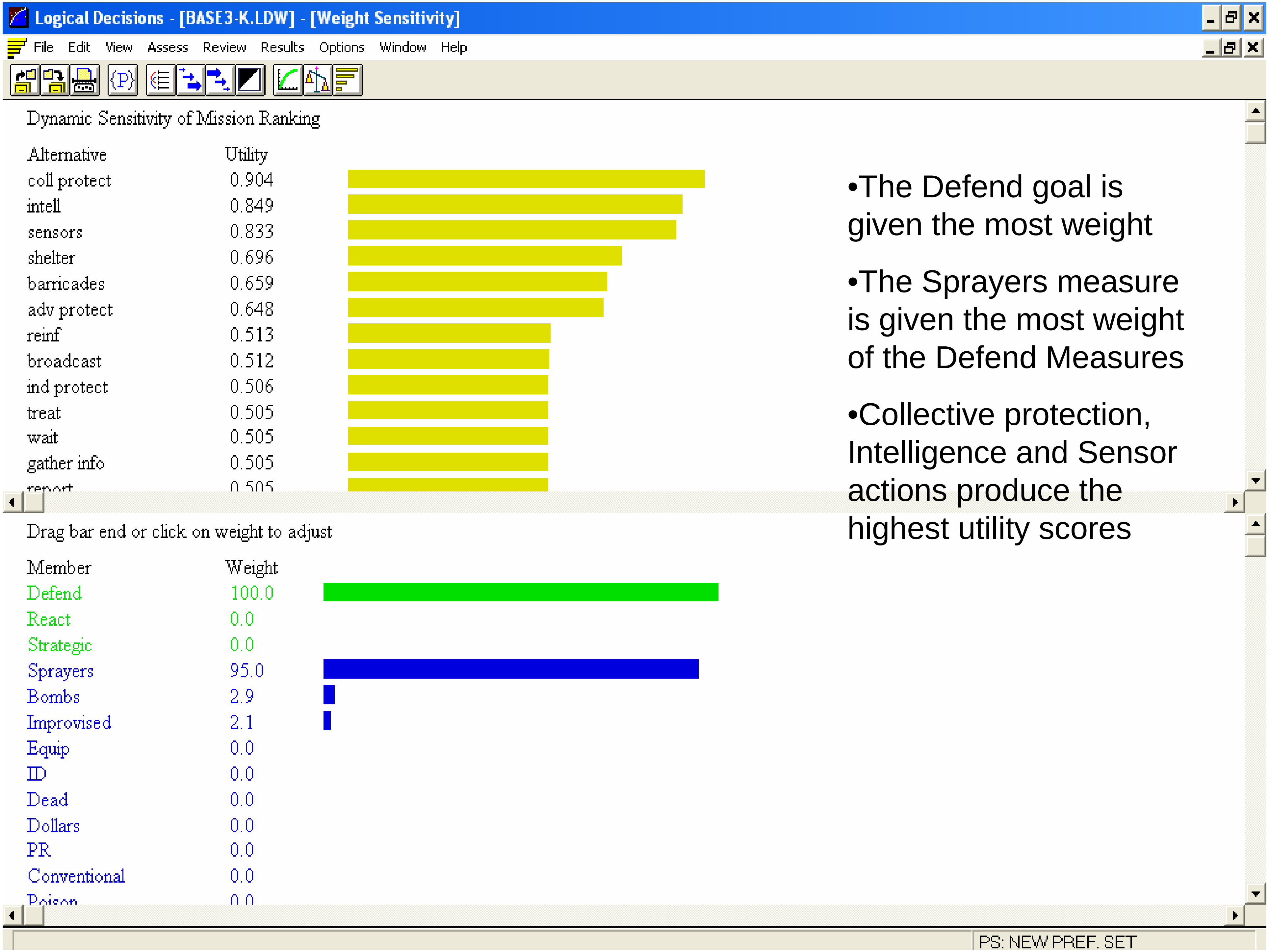
	Bombs	Command	Conventional	Dead	Dollars	Equip	ID	Improvised	Poison	PR	Sprayers
sensors	70	1	90	1	1	1	1	5.5	45	1	100
gather info	75	1	1	70	70	40	80	70	82.5	55	1
report	20	20	1	20	90	12.5	75	37.5	75	1	1
coll protect	75	82	1	85	90	80	1	70	5.5	-60	1
broadcast	32.5	40	1	65	85	-60	25	70	70	20	1
ind protect	80	20	1	85	65	1	-35	40	25.5	-5	1
reinf	50	30	1	1	50	-50	30	65	60	10	1
treat	62.5	45	1	85	-85	60	25	72.5	82.5	-35	1
shelter	10.5	50	1	70	90	20	-40	25	10.5	-15	1
deCon	1	10	1	50	60	85	1	25.5	20.5	-25	1
intell	75	1	35	1	1	1	1	65	40	1	1
evac	-35	-50	1	80	-30	-83.5	-65	15	85	-50	40
barricades	80	1	35	1	1	1	1	1	30	1	1
adv protect	35	1	50	1	1	1	1	1	22.5	1	1
wait	1	1	1	-80	90	-80	27.5	1	5.5	-5	1
dispose	1	-5	1	35	-90	-72.5	1	1	1	-15	1



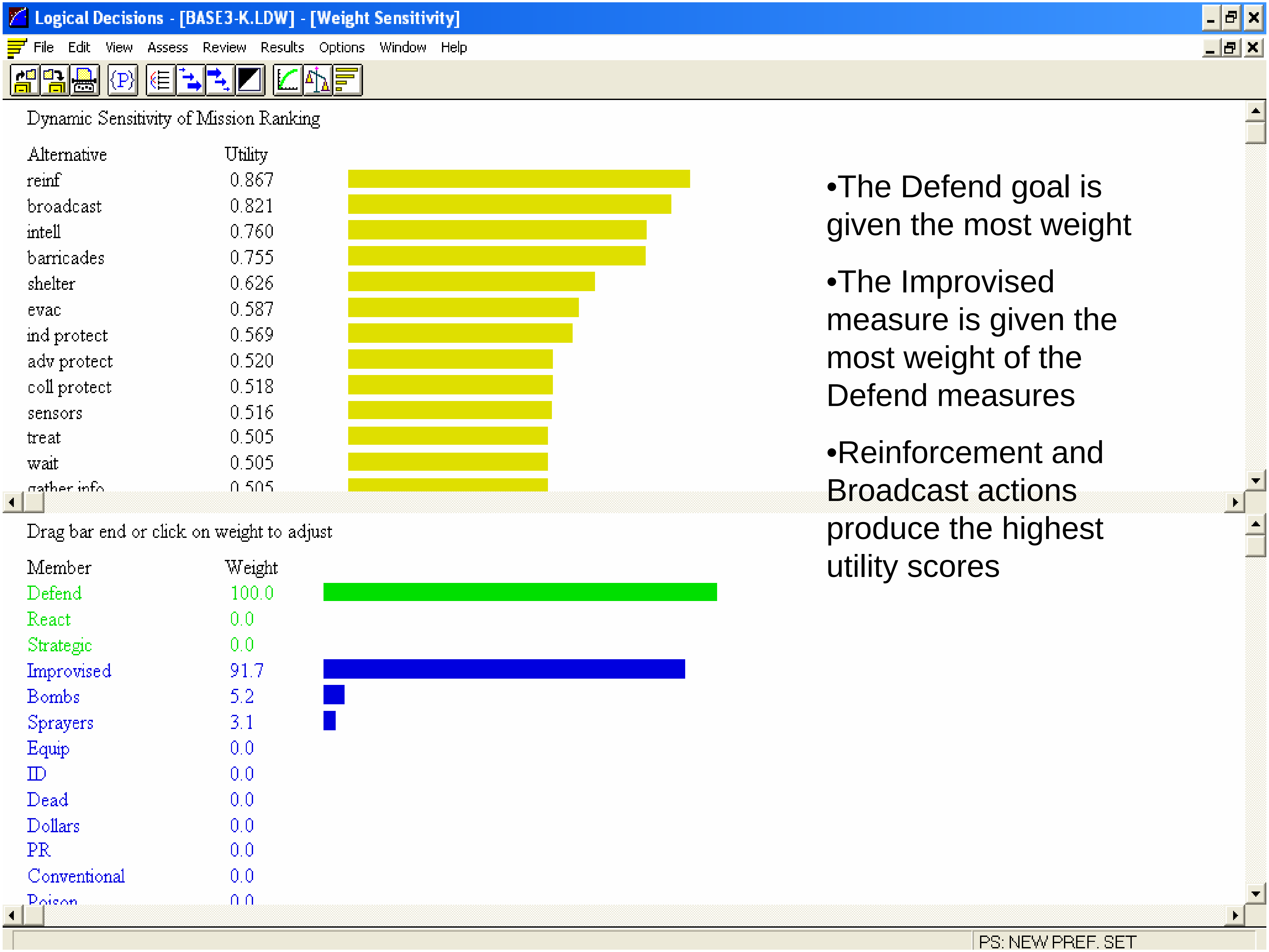
- The Defend goal is given the highest weight
- The three measures of the Defend goal are given equal weight
- Intelligence and Barricades actions produce the highest utility scores



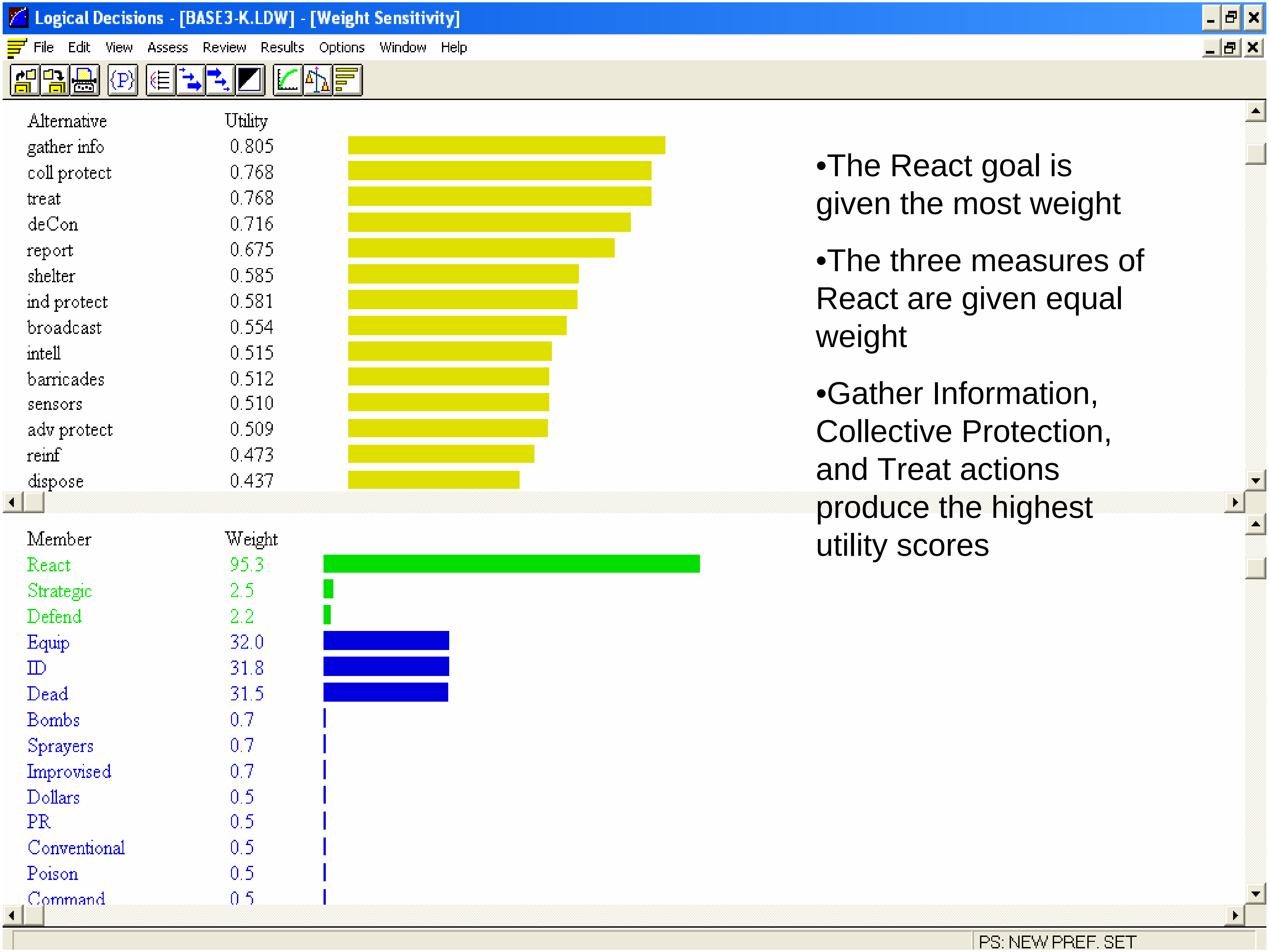
- The Defend goal is given the most weight
- The Bomb measure is given the most weight of the Defend measures
- Barricades and Intelligence actions produce the highest utility scores



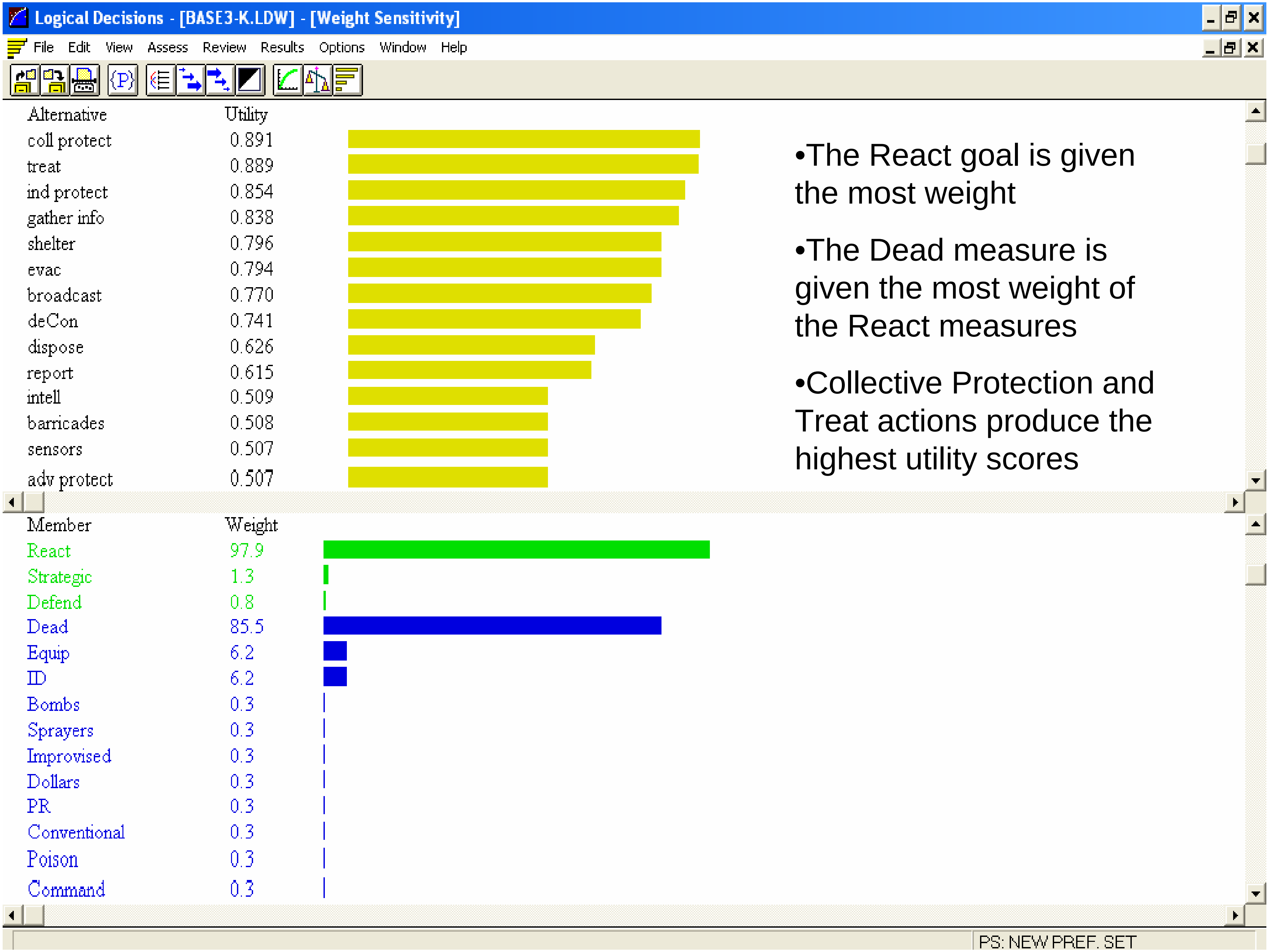
- The Defend goal is given the most weight
- The Sprayers measure is given the most weight of the Defend Measures
- Collective protection, Intelligence and Sensor actions produce the highest utility scores



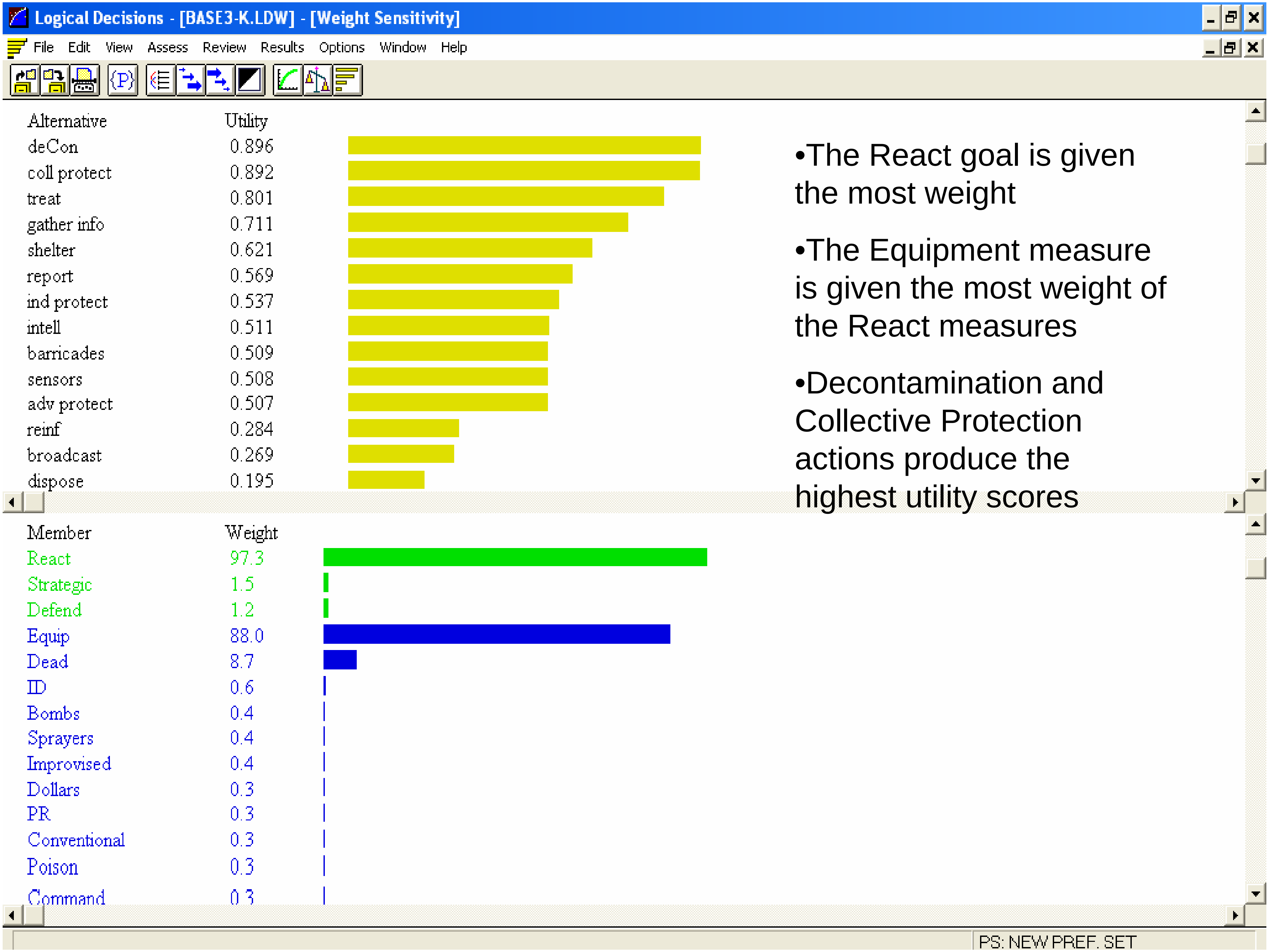
- The Defend goal is given the most weight
- The Improvised measure is given the most weight of the Defend measures
- Reinforcement and Broadcast actions produce the highest utility scores



- The React goal is given the most weight
- The three measures of React are given equal weight
- Gather Information, Collective Protection, and Treat actions produce the highest utility scores



- The React goal is given the most weight
- The Dead measure is given the most weight of the React measures
- Collective Protection and Treat actions produce the highest utility scores



- The React goal is given the most weight
- The Equipment measure is given the most weight of the React measures
- Decontamination and Collective Protection actions produce the highest utility scores

Logical Decisions - [BASE3-K.LDW] - [Weight Sensitivity]

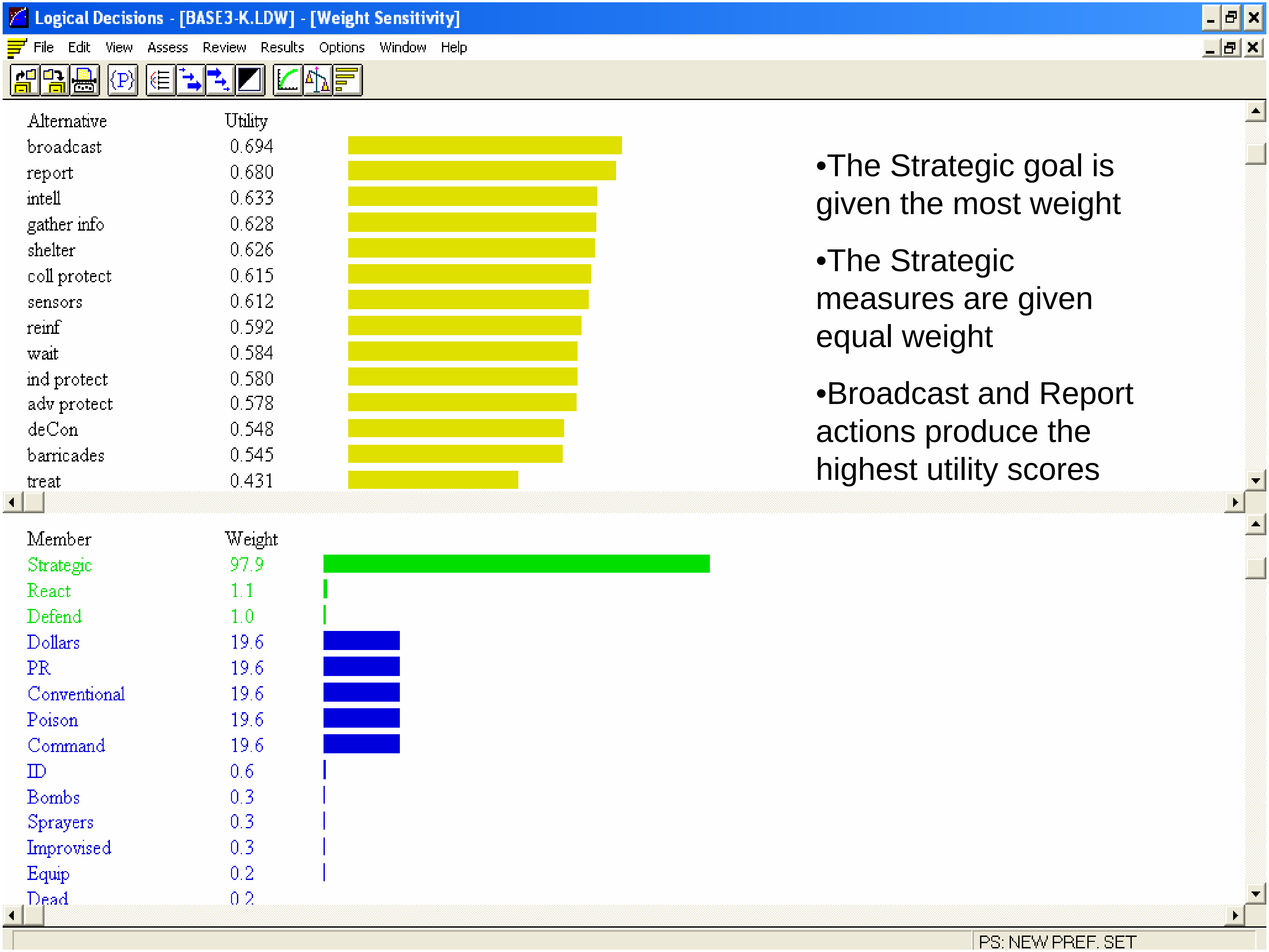
File Edit View Assess Review Results Options Window Help

Alternative	Utility
gather info	0.875
report	0.830
treat	0.650
reinf	0.613
broadcast	0.610
wait	0.566
coll protect	0.556
deCon	0.545
intell	0.510
barricades	0.508
sensors	0.508
adv protect	0.507
dispose	0.485
ind protect	0.380

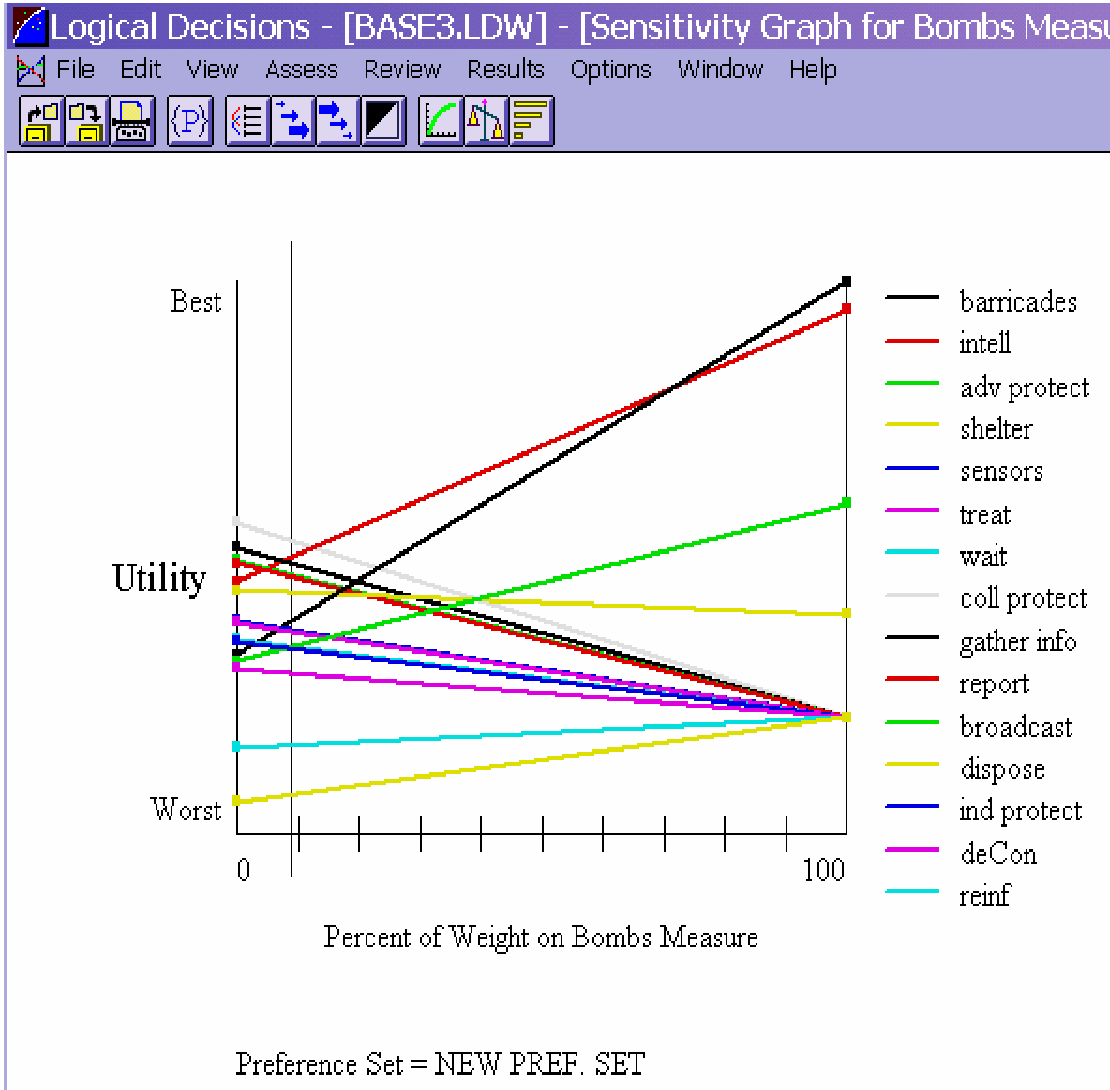
- The React goal is given the most weight
- The Identify measure is given the most weight of the React measures
- Gather Information and Report actions produce the highest utility scores

Member	Weight
React	97.3
Strategic	1.8
Defend	1.0
ID	84.5
Equip	6.7
Dead	6.1
Dollars	0.4
PR	0.4
Conventional	0.4
Poison	0.4
Command	0.4
Bombs	0.3
Sprayers	0.3
Improvised	0.3

PS: NEW PREF. SET



- The Strategic goal is given the most weight
- The Strategic measures are given equal weight
- Broadcast and Report actions produce the highest utility scores



- Current weight dictates Collective Protection

- Increased weight yields Intell

- Eventually barricades is dominant

Conclusions and Future Areas of Study

- The Combined Defense Model can be used to analyze defensive measures based on a base's individual threats and objectives
- The program operates on a user friendly interface that can be quickly learned and used
- Only preliminary inputs have been completed for the Combined Defense Program
- The relative values currently saved in the program will be analyzed for accuracy and ground truth values will be researched in order to integrate real world facts and values into the inputs for the model
- Sensitivity analysis must be performed to assure that the results are correct and unwavering

Future Steps

- Step 1: Replace relative input values with actual values
- Step 2: Allocate a portfolio which maximizes the ability to complete the mission, but is subject to a risk threshold

$$\text{minimize:} \quad Z = \sum_{i=1}^{n} \sum_{i=1}^{n} \sigma^2_{ij} x_i x_j = X^T C X$$

$$\text{subject to:} \quad x_1 + x_2 + \ldots + x_n = F \text{ (\$)}$$

$$E_1 x_1 + E_2 x_2 + \ldots + E_n x_n \geq L$$

σ = covariance

E = individual return

C= $[\sigma^2_{ij}]$ covariance matrix

L= expected return

Making the World Safer

CB System Military Worth Assessment Toolkit

Chris Gaughan, ECBC

Dennis Jones, ITT

Derrick Briscoe, ITT

Jim Sunkes, ITT

Project Overview

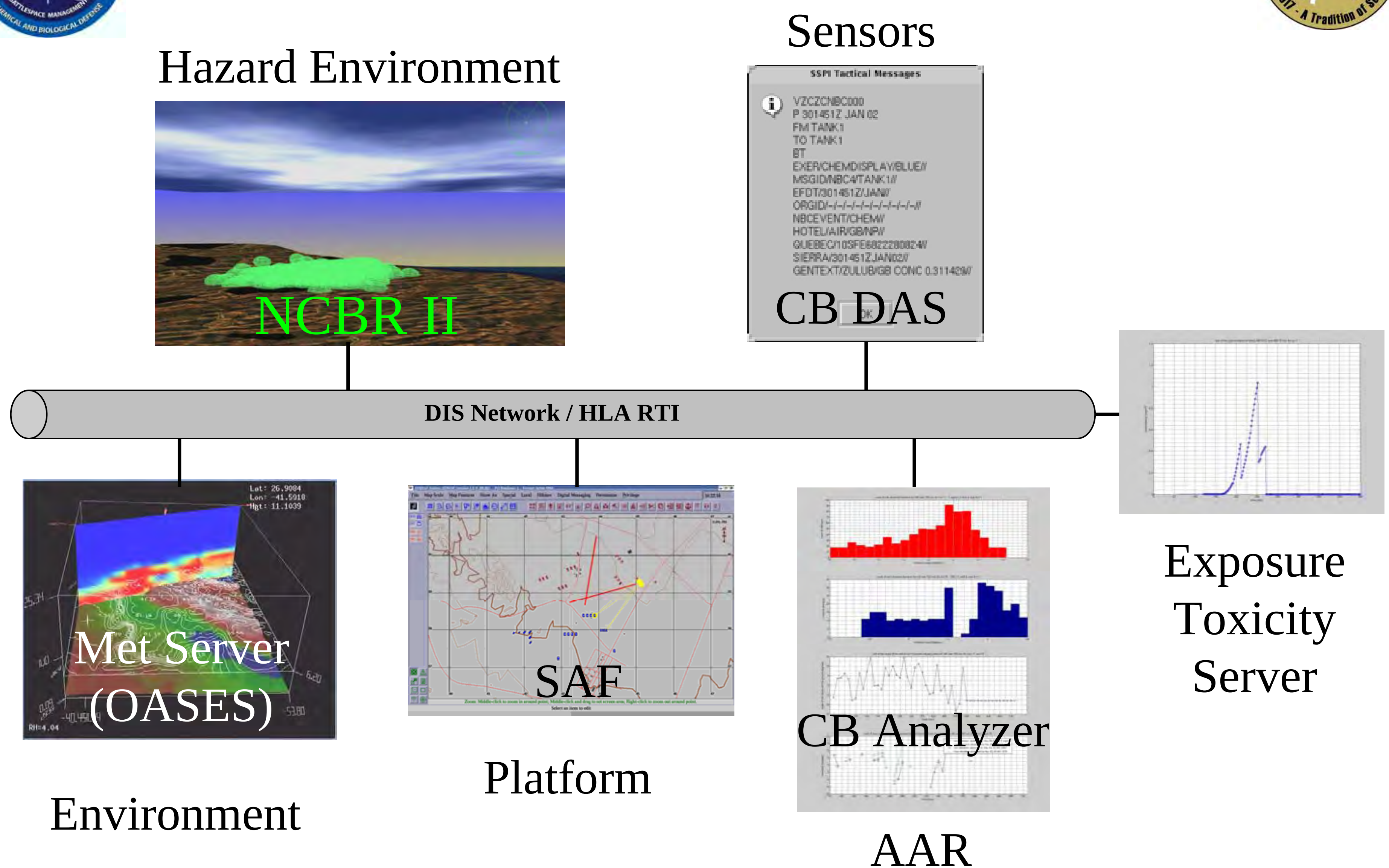
- Overall goal: extension of the CB Sim Suite to better support military worth assessments
  - Support non-real-time simulations
  - Support platform through theater-level simulations
  - Support phenomenology effects
    - Collective Protection
    - MOPP
    - Decontamination

- Benefit to the Warfighter
  - Cost effective and timely means of analyzing the impact of CB defense materiel
    - Fixed sites
    - Mobile forces
  - Development of better-defined
    - System requirements
    - Tactics, techniques, and procedures

The CB Simulation Suite

- Three principal distributed simulations
  - The Nuclear, Chemical, Biological, and Radiological Environment Server (NCBR II)
  - CB Dial-A-Sensor (CB DAS)
  - CB Exposure Toxicity Server (ETS)

CB Simulation Suite Architecture



CB Sim Suite is a set of distributed simulation tools designed to represent all aspects of CB passive defense on the tactical battle field for application to analysis, testing, and training.

NCBR II

NCBR II

- Simulates multiple CB events simultaneously in real time
  - Now expanding for smoke propagation
- Validated physics-based models for hazard propagation
  - DTRA’s SCIPUFF
  - NSWC’s VLSTRACK
- Terrain and meteorology effects
  - 4D met—external/OASES or scripted feeds
  - 3D terrain (CTDB, OOS ERC)

Medium Range Missile GB release
yellow -> vapor green -> aerosol

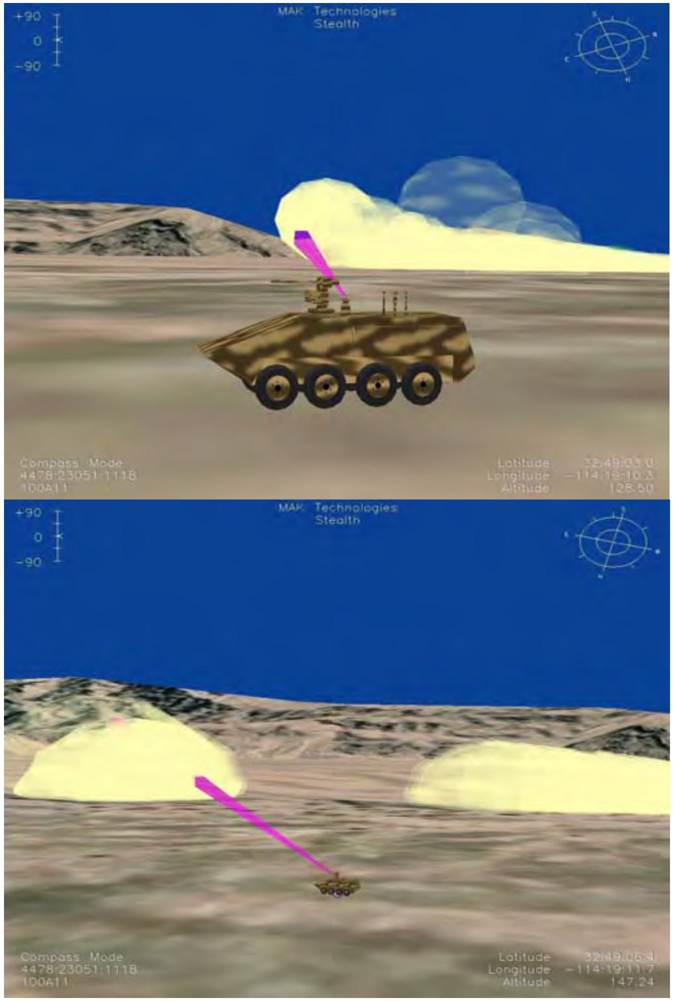
NCBR II

- Communicates environment information with other simulators
  - DIS, HLA compliant
  - XML hazard output (outputs gridded, 3D hazard data)
    - 3D Gaussian puffs (air concentration)
    - 2D conformal grids (concentration, dose, ground deposition)
  - Supports
    - Sensor modeling (point, standoff)
    - 2D/3D visualization
    - Exposure modeling (ETS)

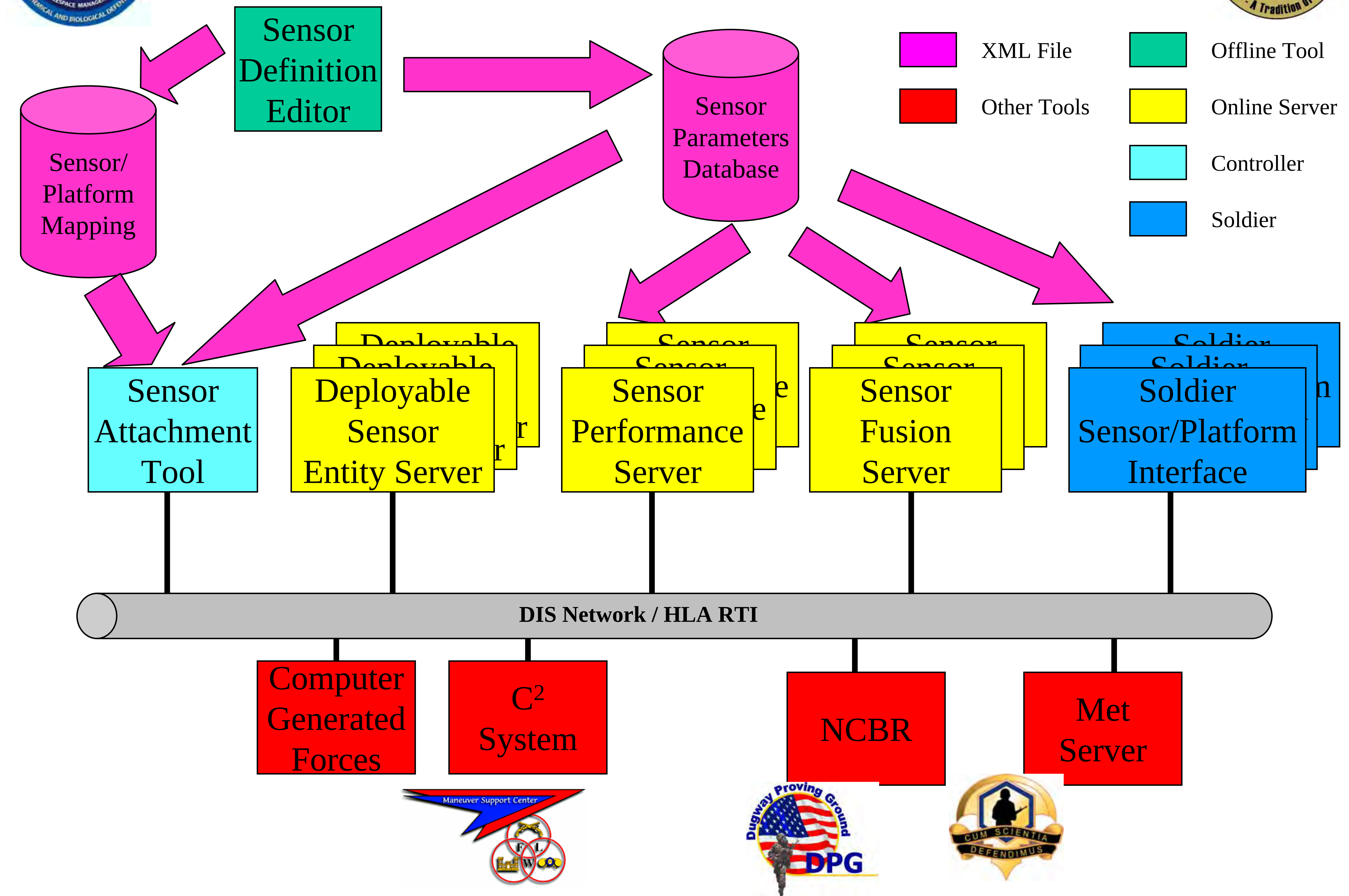
CB Dial-A-Sensor

CB Dial-A-Sensor

- Simulation tool (architecture) for representing any general technology class of CB particle and vapor sensors
  - Point and stand-off
  - Active and passive systems
- Capability to “dial” parameters to set performance characteristics for a known set of detector technology families
- Multiple data output mechanisms
  - Provide data to constructive simulations via DIS/HLA
  - Write data to a local file for analysis
  - Stimulate other system/operator software
    - Sensor user I/F
    - C2 messages

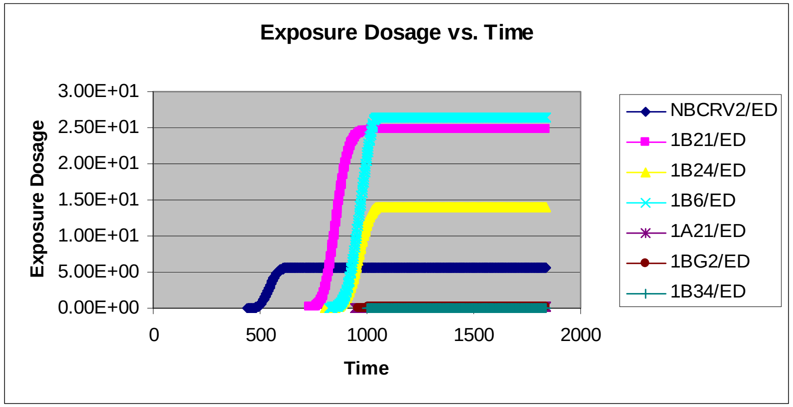


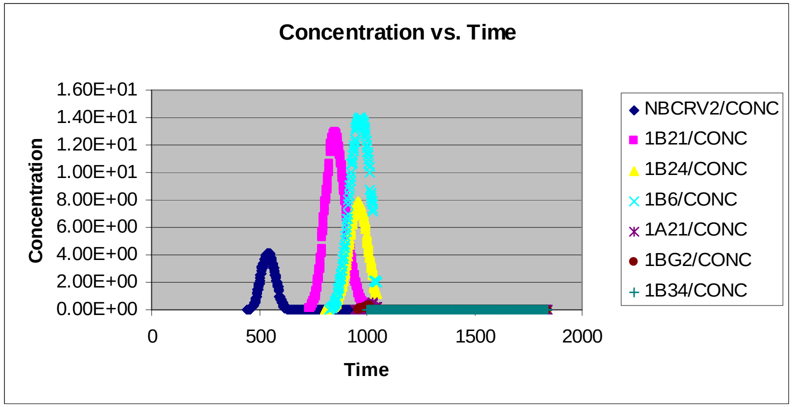
CB Dial-A-Sensor Architecture



Exposure Toxicity Server

Exposure Toxicity Server





- Scalable methodology/tool for contamination and exposure tracking to support constructive simulation entity level simulation
- Selectable fidelity/methodology for human effects/lethality modeling
- Track effects status of entities in simulation

Exposure Toxicity Server

- Design Approach
  - Uses community accepted toxicity/lethality methodologies
    - Grotte/Yang for Chem
  - Allows user to select specific implementation (equation)

- Leverages/reuses CB Dial-A-Sensor infrastructure for exposure calculation, entity tracking and subscription

- Uses XML for interface to “accredited” underlying data (e.g., agent tox data)

Who Uses the CB Sim Suite?

- ECBC Research & Technology Directorate
- JPEO CBD JPM Contamination Avoidance
  - JSLSCAD
  - Artemis
- PM Recon (Fox NBCRV trainers)
  - Ft. Hood
  - Ft. Polk
- Aviation Technical Test Center (ATTC)
- Army Research Laboratory (ARL)

Who Uses the CB Sim Suite?

- US Army Training and Doctrine Command (TRADOC)
- Army Test and Evaluation Command (ATEC) Developmental Test Center (DTC)
  - Dugway Proving Ground (DPG)
  - Virtual Proving Ground
  - Future Combat System (FCS) Combined Test Organization (CTO)
- Army Maneuver Support Center (MANSCEN)
- OneSAF Objective System

Video showing the
Sim Suite in action

Updating the CB Sim Suite

Updating the CB Sim Suite

- **Develop and integrate time management into CB Sim Suite elements using HLA time management services**
- Extend the existing ETS to include biological elements
- Develop and integrate additional representations and phenomenology
  - MOPP impacts
  - Collective protection
  - Support decontamination
- Develop an interface to widely-used constructive simulations

Development and Integration of Time Management into the CB Sim Suite

- Time management capabilities of HLA runtime infrastructure employed
- Updating components
  - ETS
  - CB DAS
  - NCBR
- Provides the ability to
  - Support slower- and faster-than real-time analyses
  - Support theater-level and aggregate-level simulations
  - Continue to support platform-level simulations
- The event manager class of each component is updated by utilizing time advance grants from the HLA runtime infrastructure
  - Overhaul of entire code

Time Management Defined

Time Management Definitions

- Coordination
  - Coordinated
    - Time advance is controlled via an external mechanism
  - Independent
    - Time advance is controlled by federates
- Advance
  - Constrained
    - Time advance rate is uniform (across all federates)
  - Unconstrained
    - Time advance rate is **not** uniform (within a federate and/or across federates)

Time Advance and Process Coordination Types

	Constrained	Unconstrained
Independent	•Real-Time and scaled Real-Time •DIS and non-Time Managed HLA	•**N/A** Meaningless in the Context of distributed simulations
Coordinated	•Not used in practice •Requires an external mechanism to control time	•HLA Time Managed •Federation driven time with non-uniform time advance

Time Advance and Process Coordination Types

	Constrained	Unconstrained
Independent	•Real-Time and scaled Real-Time •DIS and non-Time Managed HLA	
Coordina		•HLA Time Managed •Federation driven time with non-uniform time advance

All simulations in the exercise advance <u>independently</u> at the same rate using the same time scale (e.g., 1 sec = 1 sec) (<u>constrained</u>)

Each simulation in the exercise advances at its own (<u>unconstrained</u>) time scale as <u>coordinated</u> by an exercise time/event

Time Management Implementation

NCBR, DAS, & ETS Baseline

	Constrained	Unconstrained
Independent	•Real-Time and scaled Real-Time •DIS and non-Time Managed HLA	•**N/A** Meaningless in the Context of distributed simulations
Coordinated	•Not used in practice •Requires an external mechanism to control time	•HLA Time Managed •Federation driven time with non-uniform time advance

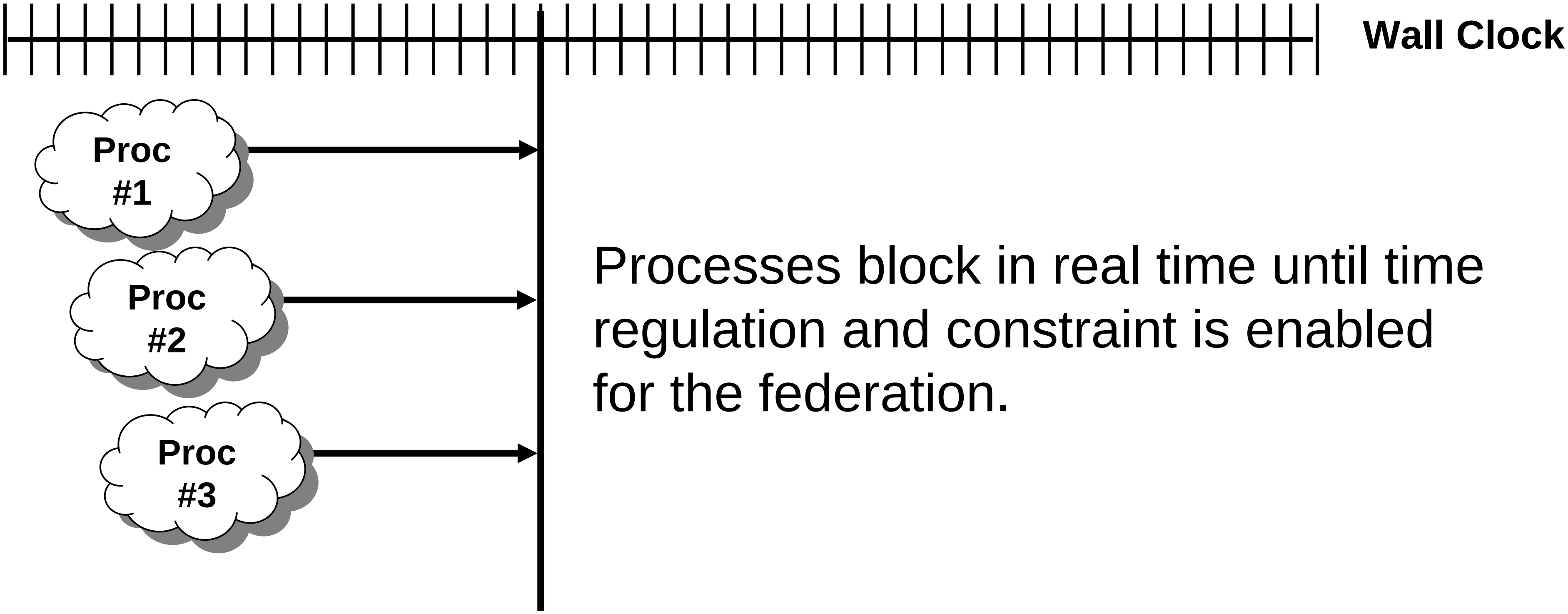
Mil Worth

NCBR, DAS, & ETS End State

How Time Management Works

Process Initialization

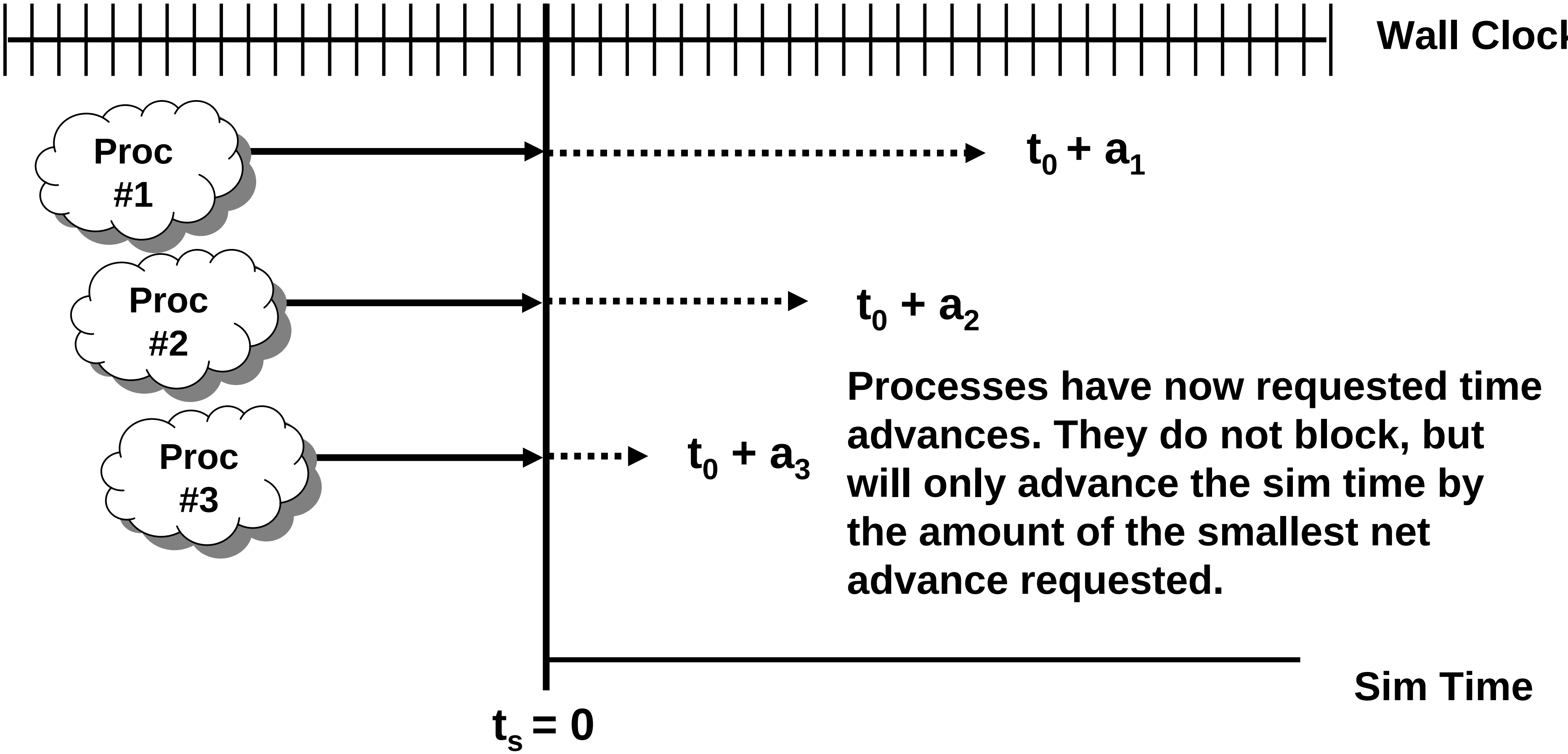
- **Initialize Process**
- **Request Time Regulation/Constraint**



Processes block in real time until time regulation and constraint is enabled for the federation.

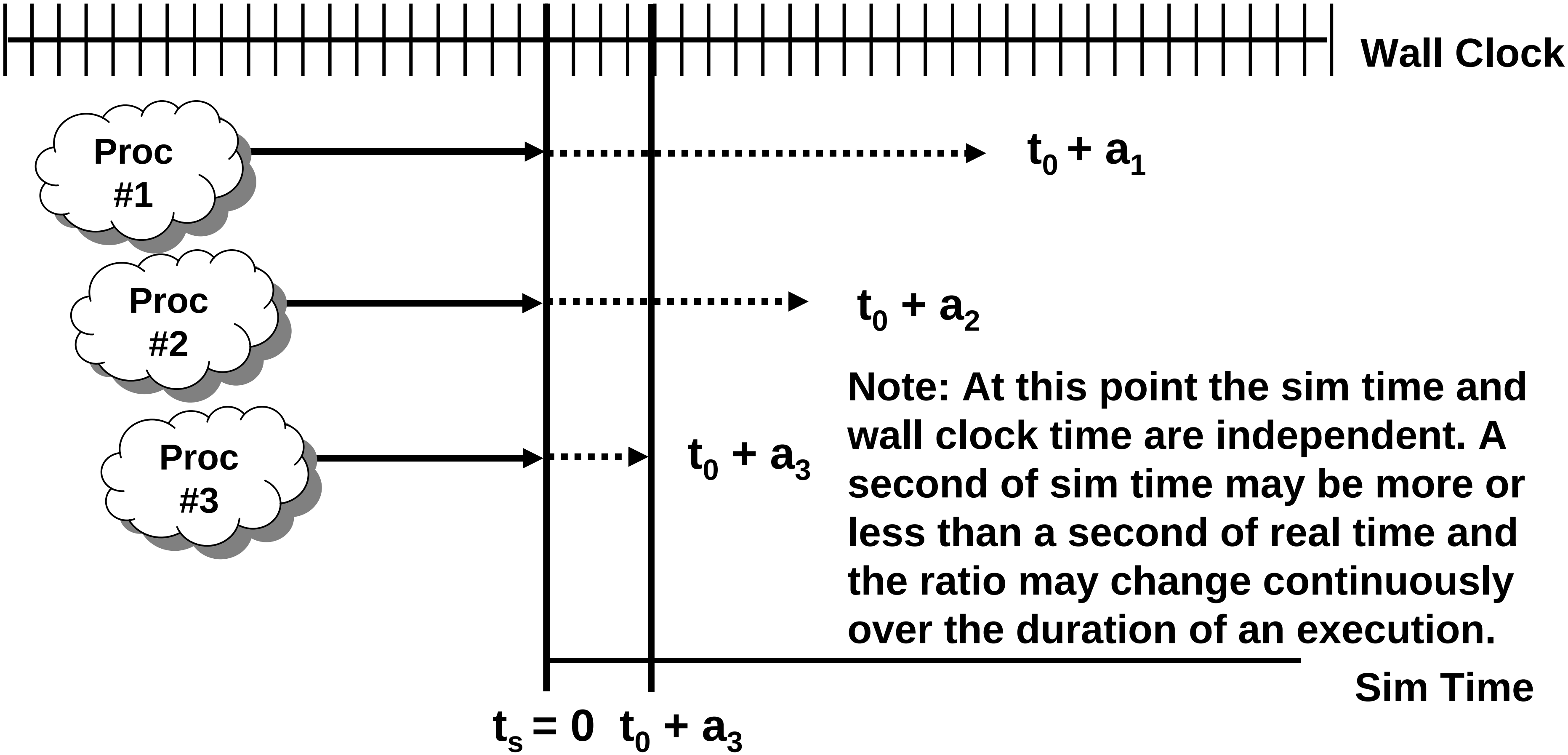
Process Execution

- Time Regulation/Constraint started
- Request Initial Time advance



Process Execution

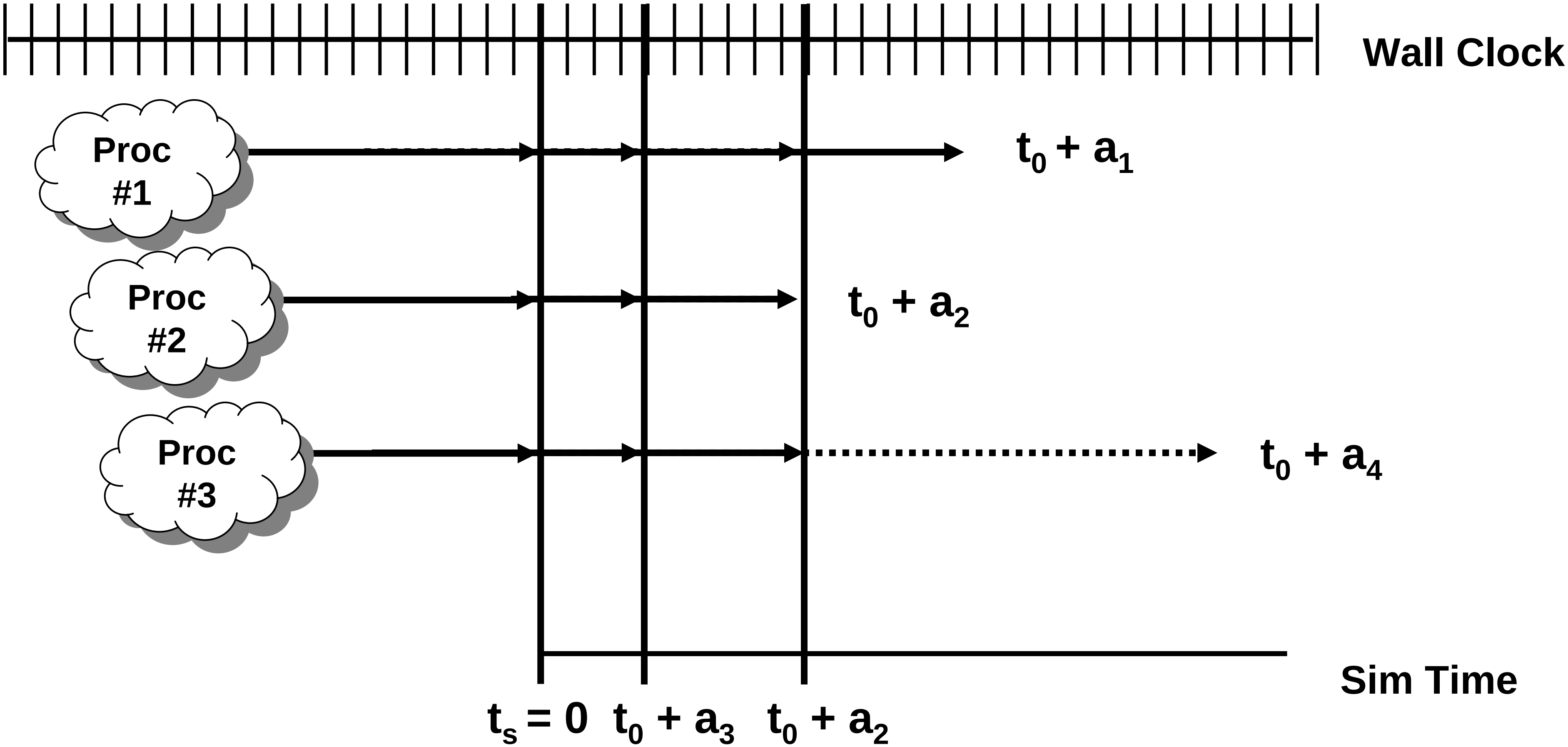
- All the processes now complete any processing to get to time t0+a3



Note: At this point the sim time and wall clock time are independent. A second of sim time may be more or less than a second of real time and the ratio may change continuously over the duration of an execution.

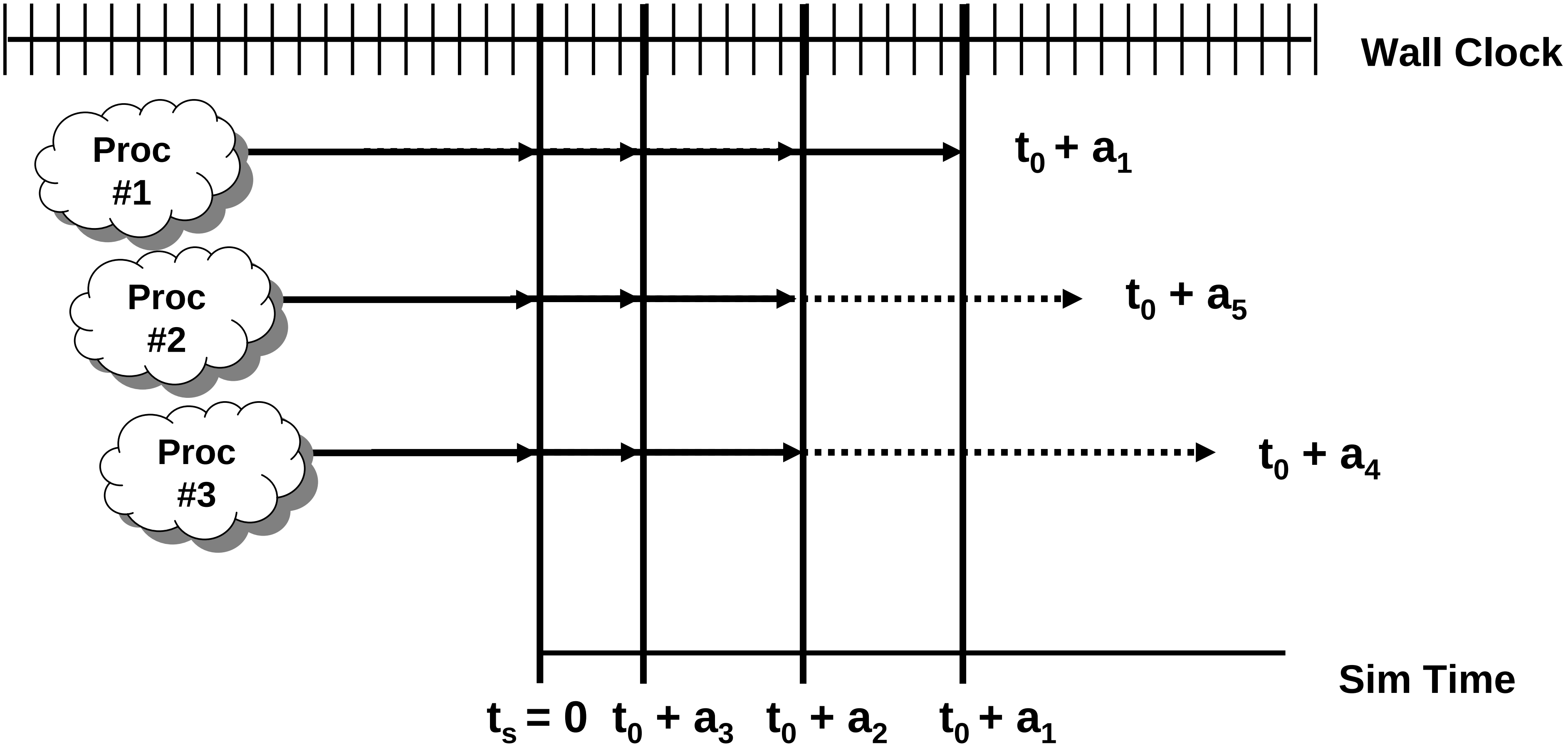
Process Execution

- **Proc #3 then issues another Time Advance Request**



Process Execution

- **Next Iteration**



Updating the CB Sim Suite

- Develop and integrate time management into CB Sim Suite elements using HLA time management services
- **Extend the existing ETS to include biological elements**
- Develop and integrate additional representations and phenomenology
  - MOPP impacts
  - Collective protection
  - Support decontamination
- Develop an interface to widely-used constructive simulations

Extend the existing ETS to Include Biological Elements

- Use a community-accepted toxicity model
  - LD_{50} and probit slope considered
    - Recommendation from senior community
  - Knowledge Acquisition Matrix Instrument (KAMI) technique also considered
    - Analyzes the effects of bioagent-induced diseases
- Bio effects occur over extended periods of time
  - Delay between exposure and onset of symptoms/impacts
  - Most simulations do not last long enough for onset of effects
  - Need the capability to work exposure portion then effects portion
    - Predosing
    - "Jump time" during simulation/non-real-time simulation
      - Non-trivial problem
      - Research area

Updating the CB Sim Suite

- Develop and integrate time management into CB Sim Suite elements using HLA time management services
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- **Develop and integrate additional representations and phenomenology**
  - **MOPP impacts**
  - **Collective protection**
  - **Support decontamination**
- Develop an interface to widely-used constructive simulations

Develop and integrate additional representations and phenomenology

- MOPP Impacts
  - MOPP all functionality in ETS
    - "MOPPall" command
  - MOPP simulation effects need to be simulated in SAFs
    - Models need to be restructured to include
      - the loss of dexterity and mobility
      - greater effects of heat stress
      - increased protection to CB at an aggregate-level (scalable)
    - Dependent on SAF and interoperability means developed
- Collective Protection (preliminary work per this effort)
  - Movement of entities in and out of collective protection sites and contamination areas tracked
    - Dependent on SAF and interoperability means developed

Develop and integrate additional representations and phenomenology

- Support Decontamination (preliminary work per this effort)
  - A contamination module (extension of ETS) that determines the contamination of an entity (vs. dose) based on
    - the entity
    - contamination type
      - Vapor
      - Aerosol
      - Deposition
      - Interaction with the hazard
  - Contamination status reported as a function of
    - Decon technique
    - Duration of decon event
    - Level of contamination
  - Dependent on SAF and interoperability means developed

Updating the CB Sim Suite

- Develop and integrate time management into CB Sim Suite elements using HLA time management services
- Extend the existing ETS to include biological elements
- Develop and integrate additional representations and phenomenology
  - MOPP impacts
  - Collective protection
  - Support decontamination
- **Develop an interface to widely-used constructive simulations**

Develop an Interface to Widely-Used Constructive Simulations

- Work continues on identifying a potential tool

- Viable candidate
  - OneSAF
    - Objective System (OOS)/WARSIM
    - Testbed (OTB)

- Modifications required on both sides of the interface
  - Inputs from the SAF drive the Sim Suite
    - Flags need to be added for MOPP, etc.
  - Outputs from the Sim Suite need to affect the behaviors of the SAF
    - Effects of CB insults need to be modeled in the SAF behaviors

Summary

- CB Sim Suite provides significant capability used across multiple domains
  - R&D
  - T&E
  - Training
- Ongoing effort rounds out phenomenology and increases applicability
- Follow-on program to mature CB Sim Suite for transition

Questions/Comments

DTRA - Modeling and Simulation/Battlespace

BO05MSB070: Multivariate Decision Support Tool for CB Defense

DTRA University Strategic Partnership

Gold Team

Frank Gilfeather, UNM

October 26, 2005

CB Defense Decision Support Tool

Purpose:

Provide an expert decision-support system to assist decision makers in allocating Science & Technology (S&T) research funding to reduce the threat and consequences of CB attacks on critical assets

- *Troops in the field*
- *Main operating bases (MOBs)*
- *Warships*
- *Embassies*
- *Ports*
- *Commands*

Acknowledged as a difficult problem with great potential, and with no clear solution

CB Defense Decision Support Tool

University Partnership Team

UNM – Frank Gilfeather, Thomas Caudell, Panaiotis, Tim Ross, Mahmoud Taha

NMSU – Jim Cowie, Chris Fields, Hung Nguyen , Bill Ogden, Ram Prasad

MIIS – Gary Ackerman, Markus Binder, Sundara Vadlamudi

Historians
Biochemists
Knowledge engineers
Cognitive Psychologists
Scientists
Engineers
Mathematicians
Political Scientists
Economists
Computer Engineers
Artists

Goal in year one

Develop a R&D Plan to Build a Multivariate Decision-Making System

Specifically:

Outline an Architecture for *CB Defense Investment Decisions* that provides:

- *Capability Assessment*
- *S&T investments Prioritization*
- *S&T Resource allocation decisions*

Perform Technique Assessments that include:

- *Strawman Applications Development*
- *Processes Validation*

Engages a broad-based team of creative professionals

Design Goals

- Develop the analytic and algorithmic framework for a tool that assists decision-makers who create funding portfolios intended to minimize threat-consequences.
- Create a feasible system architecture to evaluate modeling, analysis approaches, and user interactions within this framework.

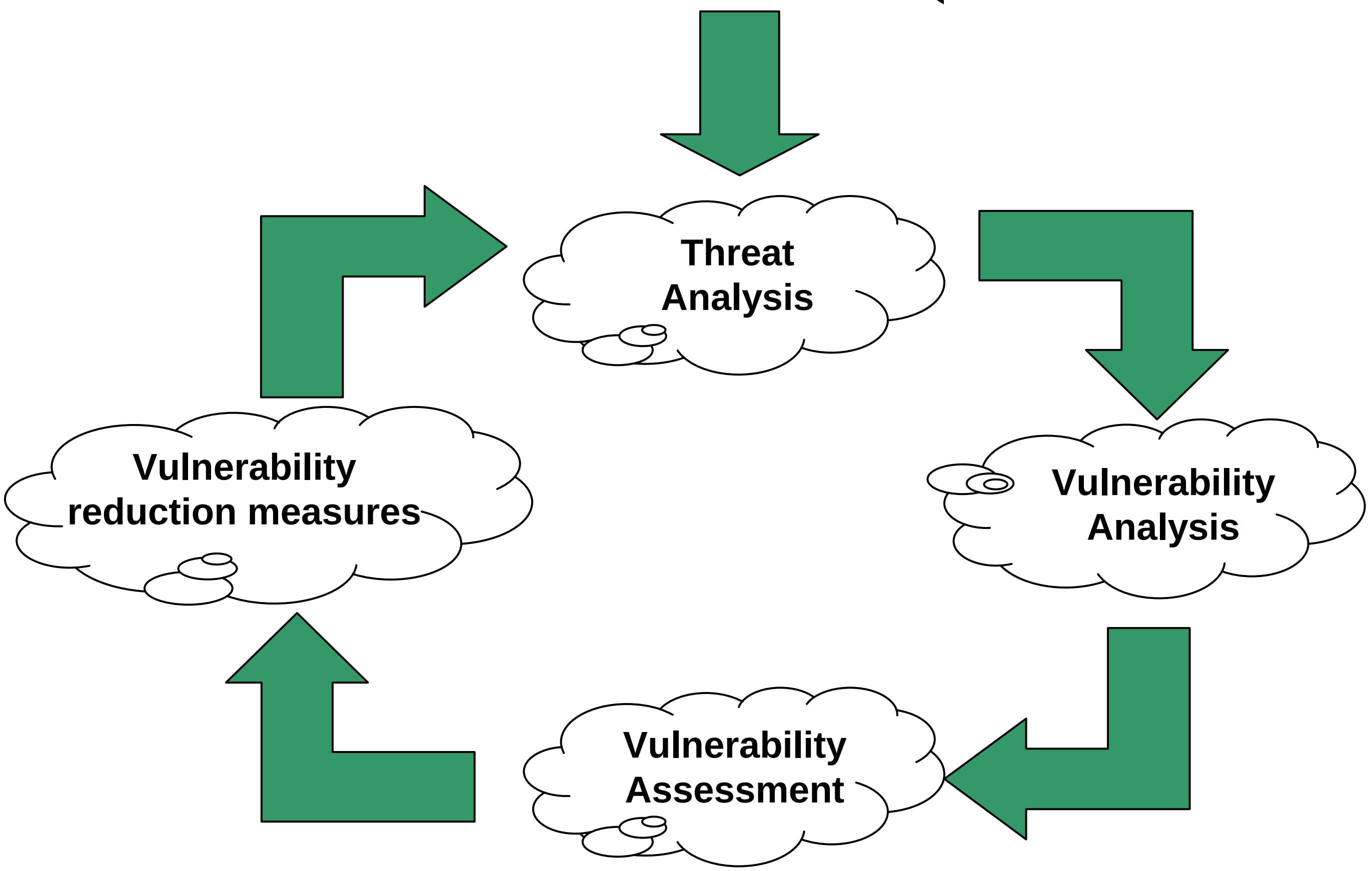
Ultimately: A usable and flexible DS tool

Design Philosophy

- *Utility to the decision maker*
    - Tied to key user profiles
    - Flexible in use
- *Transparency, not a black box*
    - Shows the evolutionary process of derived outcomes
    - Illustrates cause and effect relationships through visualization
- *Looking for "unexpected outcomes"*
    - Adds information – not just obvious outcomes
    - Minimizes the effect of preconceived notions and biases
    - Provides new ideas and perspectives of the problem space
- *Tuning is evolutionary*
    - Capable of correcting and learning from false outcomes
    - Tool improves with use

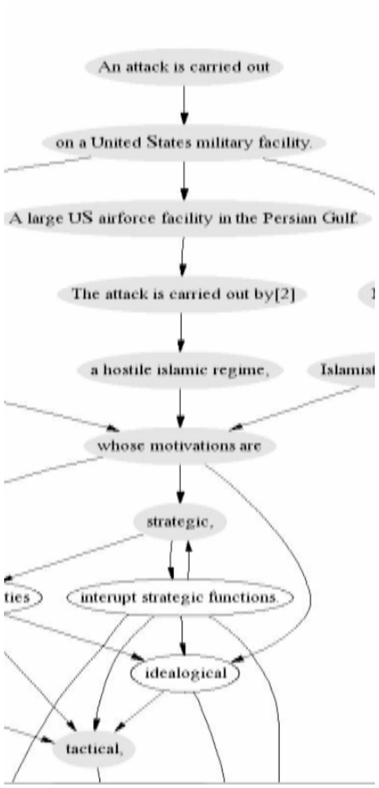
Transparency is paramount

Aligning tool with CB Vulnerability Reduction Process (FM 3-11.14)



Goal is to provide iterations for analysis

Specification of Incident Scenarios



- Discrete Possibility Tree (ala LED @ LANL)
- CBRN Data Model used
- Spanning set of incident scenarios (IS)
- Vector of consequences per scenario
- Possible continuous IS space
- Possible continuous consequence space
- Threat Analysis, Vulnerability Analysis, and Assessment are integral to the Incident Scenario space

Incident Scenarios were developed for use in our model and are key to FY06 effort

Threat and Incident Characterization
Incident Scenario Tree

- Incident scenarios:
  - Threat analysis
    - Characteristics - type
    - Attacker objectives
    - Site selection – typical and special sites
  - Vulnerability analysis/risks:
    - Site characteristics
    - Site readiness
  - Vulnerability assessment/consequences:
    - Extent of mission disruption
    - Casualties
    - Length of disruption
    - Collateral damage
    - Geo-political impact
  - Vulnerability Reduction - mitigation costs and effectiveness
- Incident data for analysis*:*
  - Expert input and simulation
  - Existing data from sites
  - Site survey and analysis

An Incident Tree based on the LANL LED program schema will determine a large set of incident scenarios from which risks (based on impact selection) will be assigned by experts.

Effects/consequences from each selection combination is an incident with a set of incident data including risk data.

Related talks:

- ***Dr. Steve Helmreich, etal., 2:30, Wed***
- ***Dr. Ram Prasad, etal., 3:30, Wed***
- ***Gary Chevez, etal., 8:35, Th***

Vulnerability Reduction
S&T Mitigation and Cost

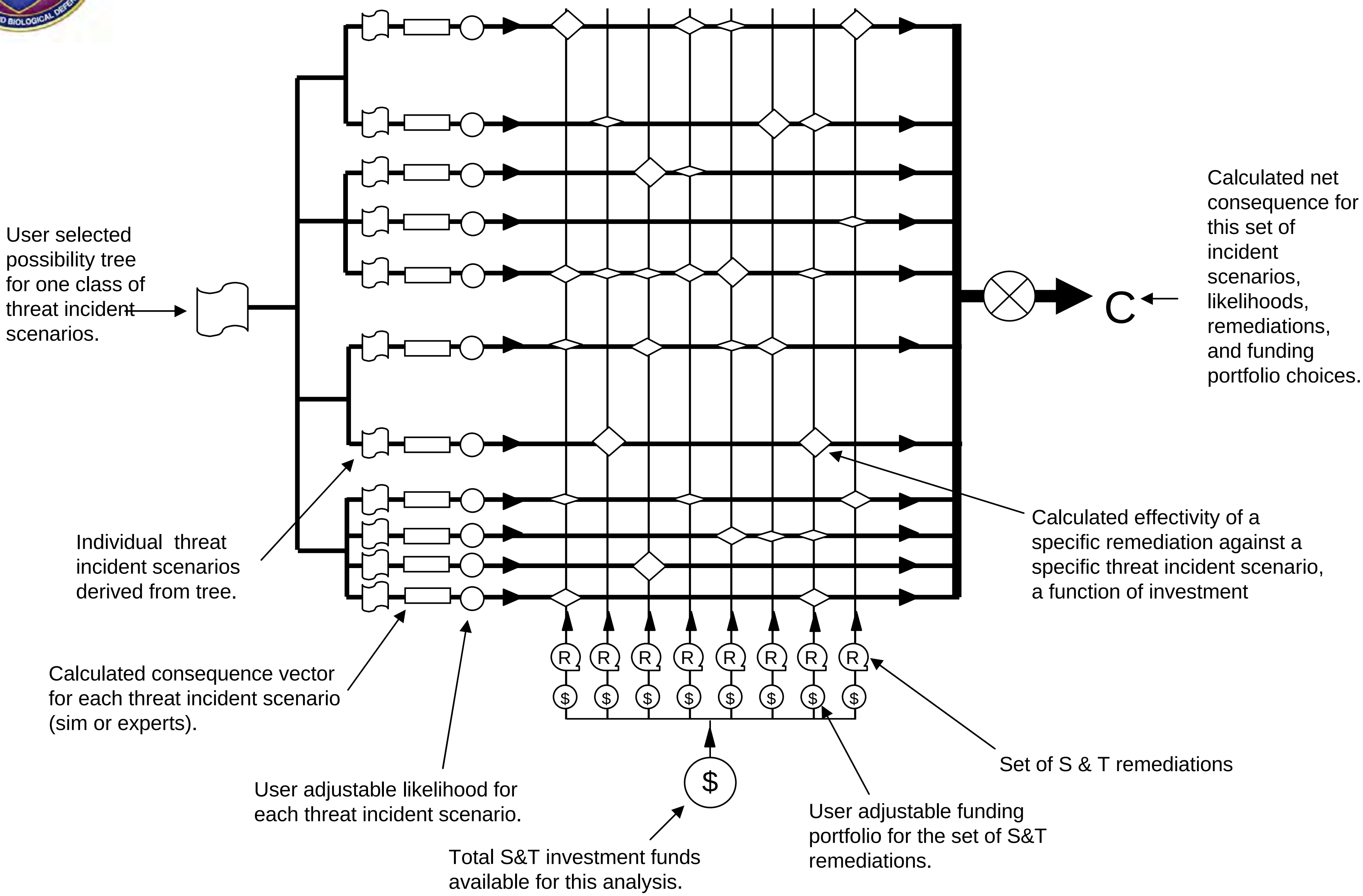
- Options
  - Current site plan status
  - COTS options - combinations
  - S&T options - combinations
- Cost of Options
  - deployment and
  - operation,
  - effectiveness,
  - time to deployment,
  - etc

User adjustable funding portfolio for the set of S&T vulnerability reductions

S&T costs and mitigation effects from each incident yields a set of S&T/incident data impacting and altering the risks from that incident

Initial Architecture

No Temporal Dynamics – First Generation

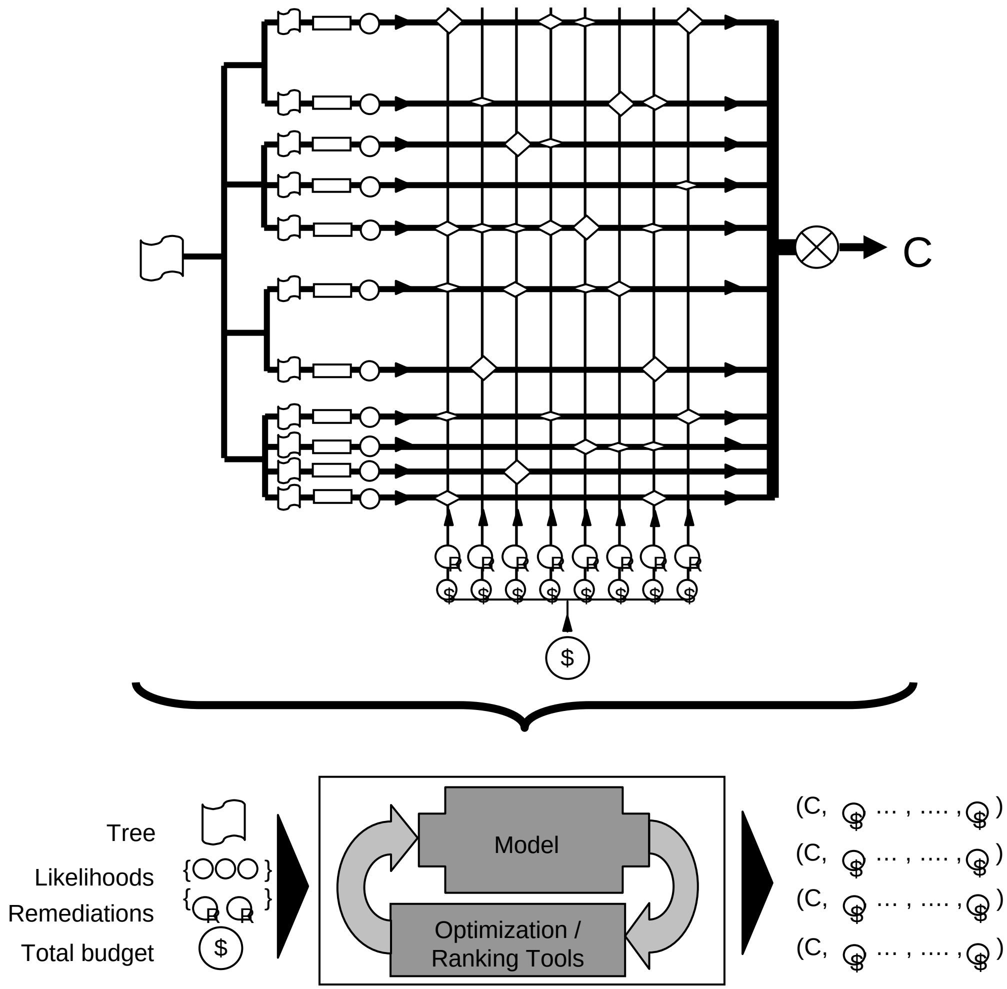


Creating Models of Costs and Effectiveness

- Relates remediation funding level to effectiveness against a given IS-scenario's consequences.
- Simulation
- Expert examples
- Interpolation using machine learning
- Knowledge based systems

Analysis, recently initiated, will be a major effort for FY06

Optimization Loop



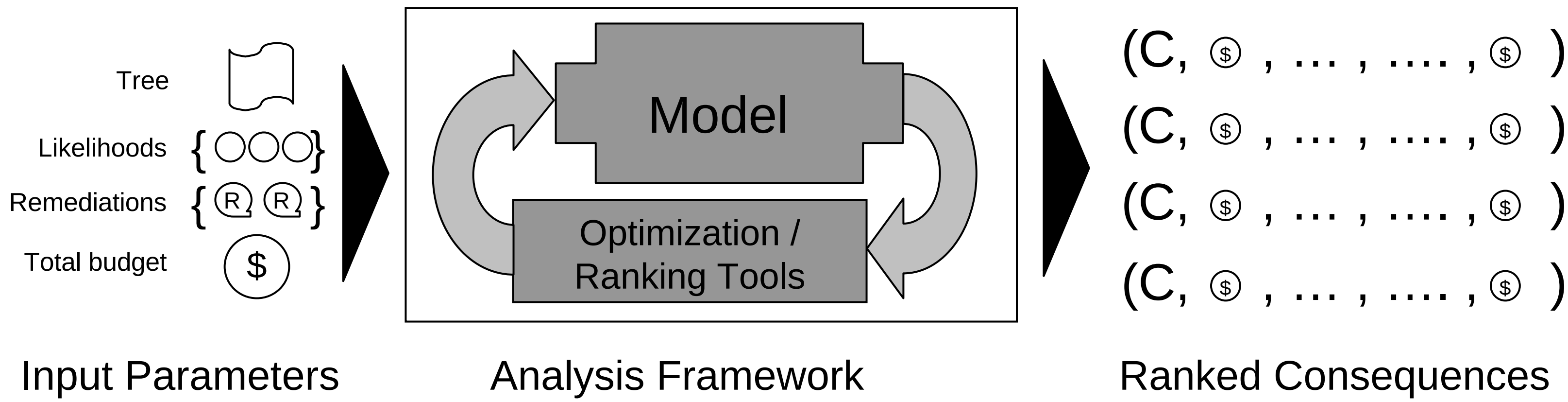
Input Parameters

Analysis Framework

Ranked Consequences

Optimization

Allocation of funds to minimize expected consequences

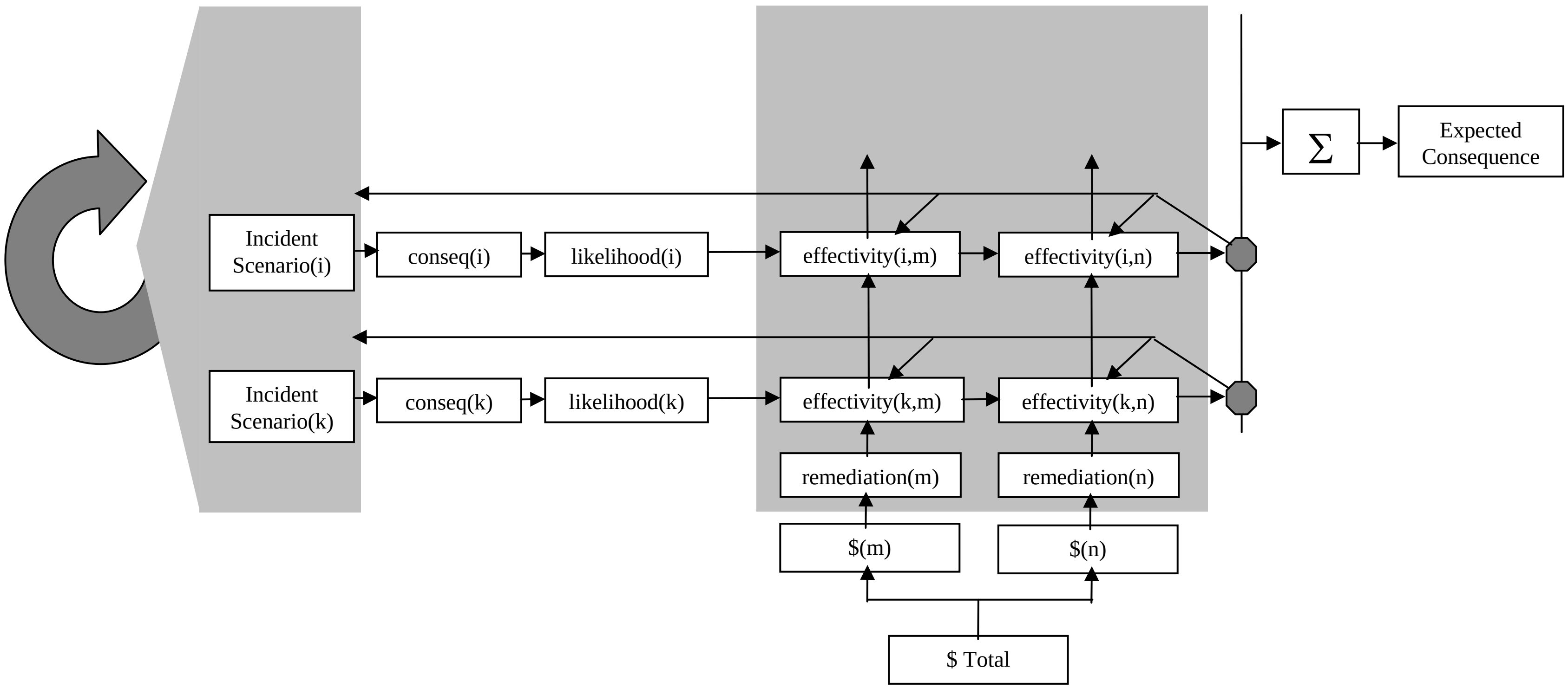


We analyzed existing optimization and ranking tools for their relevance to the problem space

Related talks:

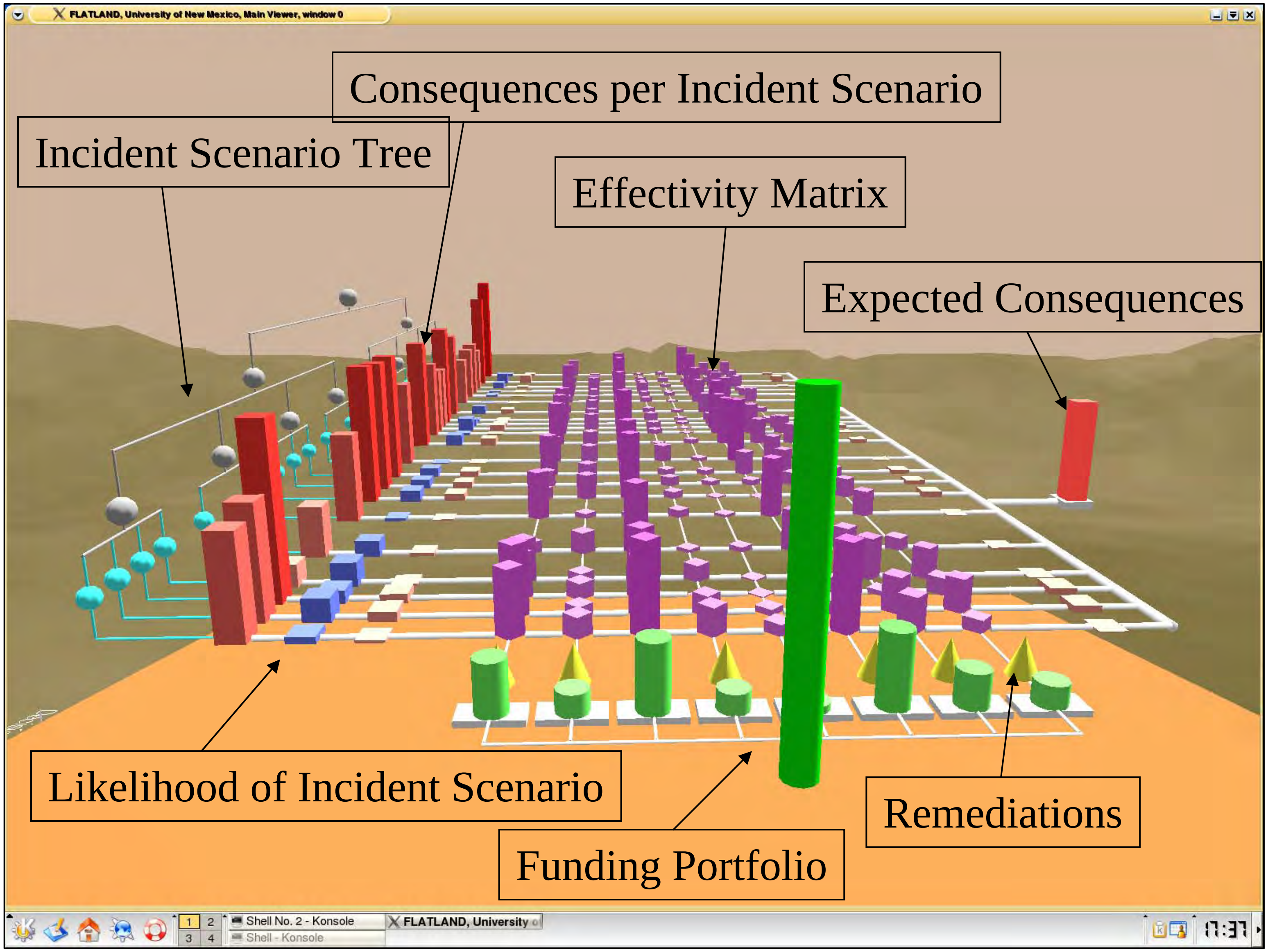
- ***Dr. Hung Nguyen, etal., 4:30, Wed***
- ***Dr. Roshan Rammohan, etal., 9:30, Th***

Temporal Dynamics



Temporal Dynamics is part of 2nd generation framework with implication for model in FY06

Visualization of Mockup System (1st Generation)



Visualization Features

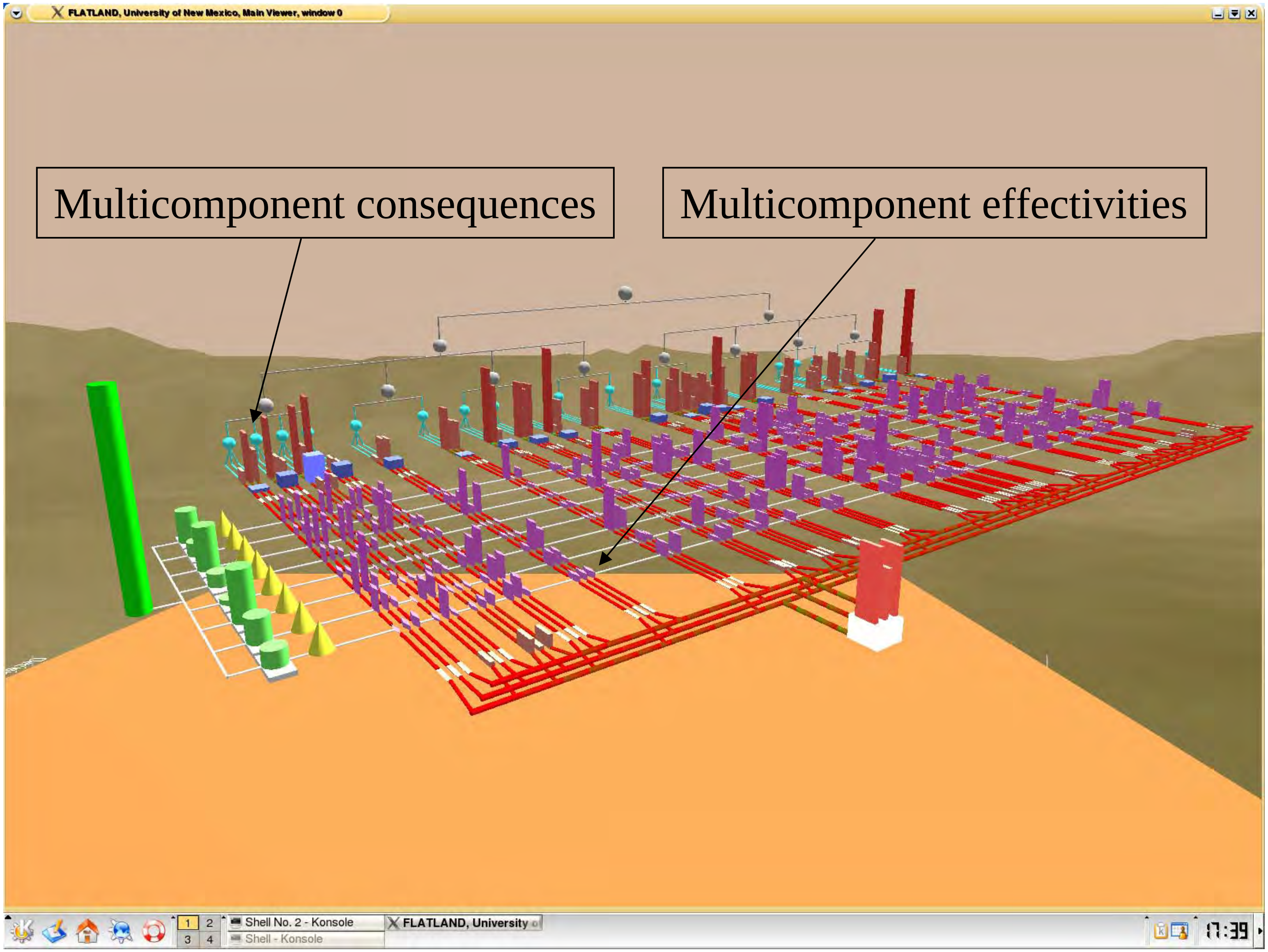
- Complete visibility into computational model
- Multi-sensorial approach increases comprehension
- Consequence-flow metaphor
- Real-time user adjustable parameters
- Multi-resolution to manage complexity
- Drill-down for more details
- Animation of calculations and optimization

Visualization interface provides flexibility and transparency

Related talks:

- ***Dr. Tom Caudell, etal., 2:00, Wed***
- ***Dr. Panaiotis, etal., 9 AM, Th***
- ***Bill Ogden, etal., 4:00 Wed***

Visualization of Mockup System



FY06 Effort

- Refine Framework – 2nd Generation
  - Incident Scenario (IS) framework and representation trees – define and tie to CBRN data model
  - Remediation and cost representations – define and analyze
  - Effectivity representations – define and analyze
  - User profiling – provides for multiple user-types
  - Temporal issues – define and embed
  - New complex analysis tools developed as framework evolves
- Mock-up Tool
  - Provide a limited working model
  - Match analysis tools to specific use
  - Test and obtain user assessment
  - Consider potential of wider use

"Net-Ready" CBRN Sensors – A Way Forward…

Presented to: 2005 Chemical and Biological Information Systems (CBIS) Science and Technology (S&T) Conference

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Outline

- What is "net-ready"?
  - To the Warfighter…
  - To the Policy / Requirements / Program Professionals…
  - To the Engineers…
  - To the "10 year old"…
- Common Information Technology (IT) Platform for Sensors
- Desired Capabilities
  - General
  - Data and Service Standards
  - Reusable Host Platform
  - Modular Components
  - Security
- Conclusion

What is “Net-Ready”?

Net-Centricity* is a transformation enabler that empowers all users with the ability to easily discover, access, integrate, correlate and fuse data/information that support their mission objectives.

Systems exchange common data through a set of common services and interfaces which allow for flexible and dynamic specification of data producers and consumers and data routing (i.e.: Scales easily)*

* JFCOM/J8 – Joint Interoperability & Integration / C2 FCB

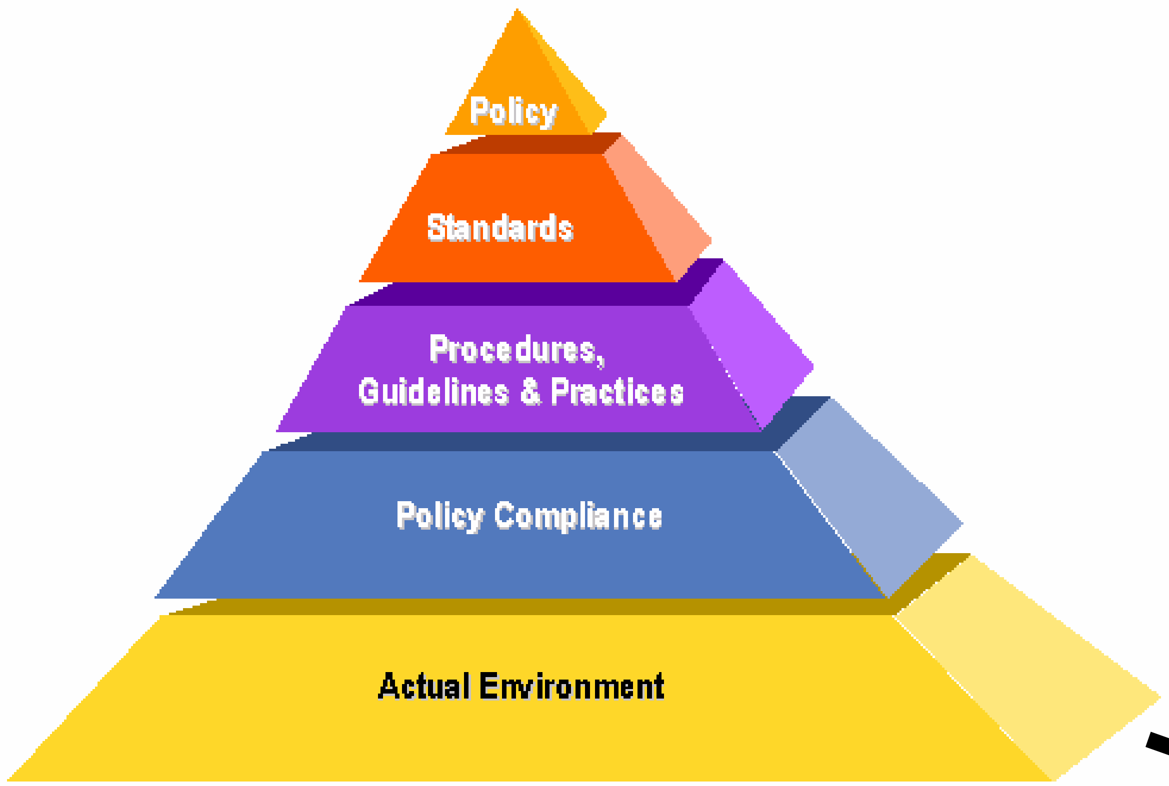
What is "Net-Ready"?
To the Warfighter…

To the Warfighter…

- **Easily find, access, update, and share information resources relevant to their Area of Responsibility (AOR) and tasking**
- **Quickly deploy assets that have an information component to them with minimal setup and configuration expertise required**
- **Easily access wired / wireless connected sensors**
- **Dismount and carry forward handheld sensors that remain connected to the network (wirelessly)**
- **Sensor data seamlessly integrates with my C2 platform**
- **Plug and Play (PnP) sensors into the network**

"Even my 10 year old knows what net-centric is…" and practices it…!!!

What is "Net-Ready"?
To the Policy / Requirements / Program Professionals…



To the Policy / Requirements / Program Professionals…

- **DoD Policies:**
  - **CJSCI/M 3170.01 Joint Capability Integration and Development System (JCIDS)**
  - **CJCSI 6212.01C Interoperability and Supportability of Information Technology and National Security Systems**
  - **DOD Architecture Framework (DODAF)**
    - **Provides a process and representation framework for developing and sharing architectures**
  - **Global Information Grid (GIG) and Net-Centric Operations Warfare Reference Model (NCOW)**
    - **Provides pervasive network connectivity to DoD Systems**
  - **GIG Network Centric Enterprise Services (NCES)**
    - **Provides Core Enterprise Services to DoD Systems beyond 06**
    - **Facilitates Community of Interest (COI) shared services**
  - **Net Ready KPP**
    - **Partially based on LISI and Inspeqtor tool**

To the Policy / Requirements / Program Professionals…

- **Compliance - measure Overall Degree to Which a Systems Makes its Services Net Accessible – Net-Ready KPP**
  - ***Compliance with the Net-Centric Operations and Warfare Reference Model***
  - ***Compliance with applicable Global Information Grid Key Interface Profiles***
  - ***Compliance with DoD Information Assurance requirements***
  - ***Production of DoDAF products***

NR-KPP: Degree to Which a System Makes Data and Services Net Accessible

To the Policy / Requirements / Program Professionals…
JPEO-CBD SSA Activities

Contract Language and New Net-Centric Requirements

Specify reuse and extension of → CBRN Data Model and XML Schema

Specify compliance with W3C standards reusing and extending existing services resulting in → SOA

Specify reuse of certified security solutions resulting in → Quicker DIACAP

Translate the vision into specific guidance to JPEO-CBD developers – S&T should start with a common reusable "net-centric" IT platform and Test Community must develop robust test strategies to verify.

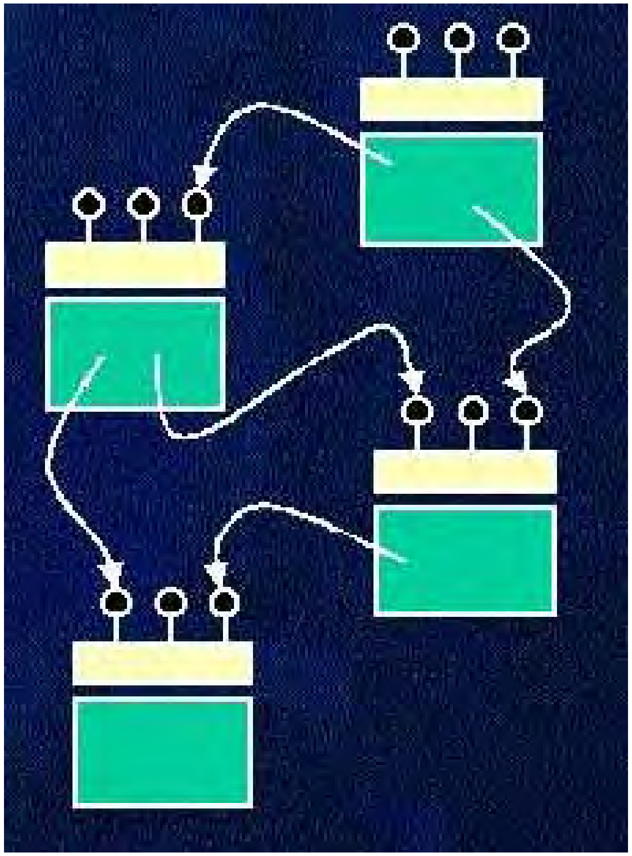
To the Policy / Requirements / Program Professionals…
Acquisition Goals

- **QUICKER fielding and LOWER procurement and sustainability costs through standardization**
  - **Common software and hardware platforms**
  - **No LSI's to "integrate" sensors into host/C4ISR systems…**
  - **PnP easily configurable common components**
  - **Reduced cost of operation and maintenance**
  - **Reduces deployment costs (with little or no integration costs)**
  - **Open standard interfaces**
    - **focus more on what to do with the data than how to decipher N different sources (no stovepipe solutions)**

What is "Net-Ready"?
To the Engineers…

To the Engineers…
Best Practices

- Common software services that are based on a common data model, common schema, and common protocol
  - Sensor data is already in the format expected and can be readily stored in my host database and/or pushed to decision support systems
  - Data Integration becomes translation between schemas, vice programming
- Modular, reusable, domain independent software components
  - Common software driver reused for all new sensors for sending / receiving sensor data
  - More configuration and less new development

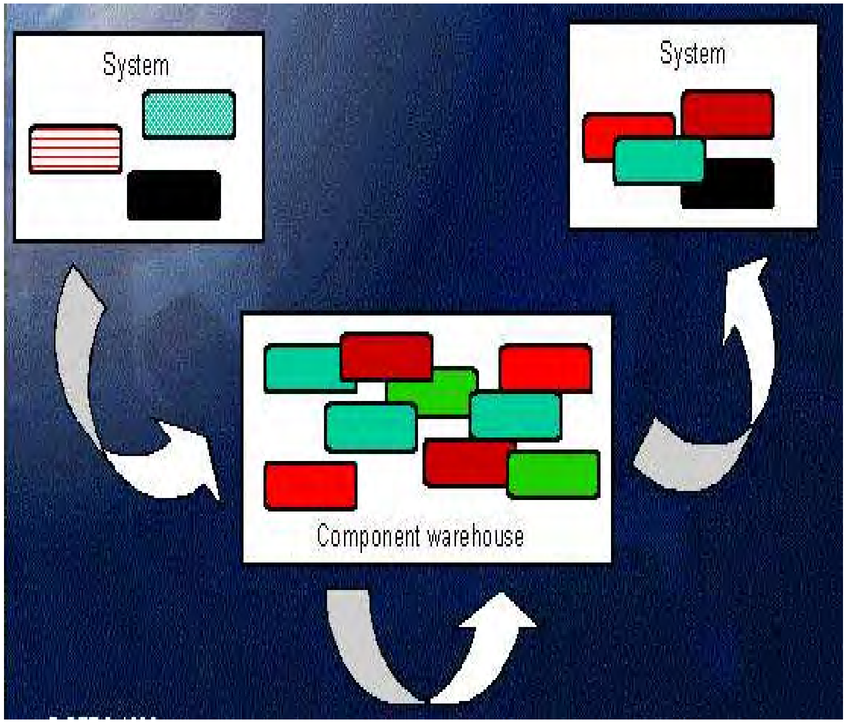


***More** upgrade, configuration, and component provisioning…*

***Less** new development… **Modularity** and **Reuse** are key.*

To the Engineers…
Facilitation of Net-Centric Operations

- Component configuration and deployment and dynamic software load in-the-field provisioning to well defined interfaces:
  - Component upgrade and component level integration
  - PnP components provisioned based on environment (e.g. wired, wireless, bandwidth restrictions (specification of common binary compression/decompression techniques), modifiable encryption/decryption, operational vice service/maintenance)…



Late binding… distributed interaction… assembly vice development…

To the Engineers…
Developer Guidance

- Systems and technical views of DoDAF architectures that specify technology standards, explain how systems communicate, data passed, and how data are represented
- Supports the W3C WS-I (Web Services Interoperability) Basic Profile (e.g. XML, SOAP, WSDL, UDDI, HTTP(S))
- Configuration controlled components and artifacts:
  - E.g. Architecture and Data Models, Engineering Reference Model Specifications, Technical Specifications, Common Software Services, and Common Hardware platforms
  - CBRN Data Model must be maintained and up-to-date and in sync with the sensor-interfaces
  - Modularity to enhance compatibility across versions
  - *Joint CBRN (JCBRN) Architecture Working Group, Data Working Group, and Configuration Management Plan Established…*

Ensuring interoperability and portability starts with the specifications…

To the Engineers…
Testers Guidance

- Implies redefinition of system vice “service” boundaries when testing a net-centric service vice a SoS or FoS composition thereof
- Encapsulate testing of the “IT” component vice “CBRN” testing
- Common IT services => common test strategies and facilitates the automation of testing IT services

New requirements imply new test cases and testing strategies… however, as we develop common services, testing should become easier, not harder.

What is "Net-Ready"?

To the "10 Year Old"…

Plug-n-Play on-the-go!

"Google" Anything I Want!!!

On Line Gaming!

Play With My Friends Anywhere / Anytime - Online!

To the "10 Year Old"…

- Discover who is on line… chat with my friends… share information with my friends – use their toys and let them use mine… all on-line…
  - *Robust inexpensive real-time distributed collaboration and resource sharing…*
- Online gaming – discover game servers and other gamers and start seeing them and their actions/status on my display and have them see my actions/status on theirs…
  - *Distributed situational awareness engagement applications…*
- Wireless on the go is a way of life now – my cell phone, my PDA, my IPOD (look, I'm "Podcasting"!) and dock it when I'm at home
  - *Same components used on the move or docked at home*
- PnP peripherals – I want to connect something new so I buy it and plug it in and use it
  - *Plug it in, load the driver, configure the device, get the data…*

Tomorrow's Warfighters already live in a net-centric world!

Net-Ready Sensors…

Net-Ready Sensors

- **Common CBRN Sensor Platform** – *the fully encapsulated net-centric reusable software service that communicates securely via the CBRN XML Schema using a common protocol…*
- All CBRN sensor data that can be transmitted, received, and stored will use the CBRN Data Model as the basis for data representation!
  - *Specification of sensor data entities and attributes in the CBRN Data Model is underway NOW, being lead by JPM IS Data Team.. Other specifications will follow…*

Standardization of the interfaces across all CBRN sensors/devices!

Key Assertions
Common IT Platform for Sensors

- Common IT platform for sensors:
  - **Sensor data format** and **protocol** that exists between a sensor and the host/user platform…
  - IT components associated with making a device “net-ready” are completely independent of the domain-space in which that device will be deployed…
  - NOT addressing data fusion

- No new radical development here –
  - Bringing CBRN Sensors into the 21st century…
  - Leveraging commercial and leading-edge DoD agency efforts
  - The “S&T” is really education, socialization, and miniaturized integration of existing components into CBRN sensors…

Starting with common open standards in S&T makes it much easier to evaluate new technology and transition it into programs of record.

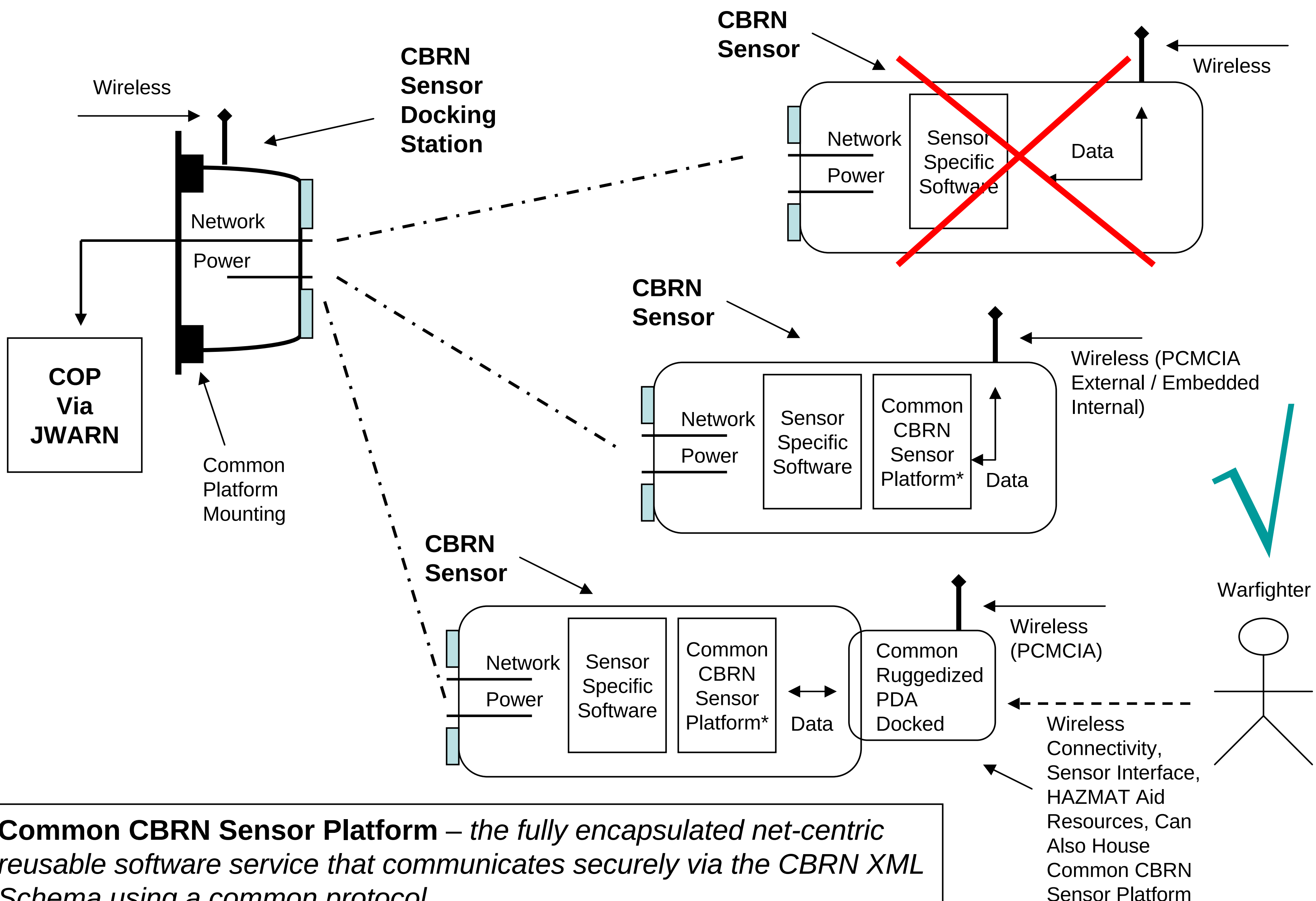
Key Assertions

Sensors in a Service Oriented Architecture

- **For net-centric sensors to be successful, the interface standards must be widely accepted. To enable such wide acceptance, the standards used for these services and the technologies that implement those standards should meet the following criteria:***
  - **A sensor should be able to service requests from any client regardless of the platform on which the client is implemented***
  - **A client should be able to find and use any sensor regardless of the service's implementation details or the platform on which it runs***

**** Derived from Designing Web Services with the J2EE 1.4 Platform - Overview of Web Service Standards.***

Desired Capabilities - General



Common CBRN Sensor Platform – *the fully encapsulated net-centric reusable software service that communicates securely via the CBRN XML Schema using a common protocol…*

Desired Capabilities - General

- Software defined sensor platform that exploits network connectivity to perform its mission in support of diverse Warfighter needs
- Directly supports and encapsulates the DoD net-centric strategy … bring “net-centricity” to sensors via common reusable IT components
- Scaleable PnP architecture securely operable over the Internet
- Immediate integration into system and common operational picture by the Warfighter via JWARN, not a developer / integrator
- Mounts on vehicles and plugs into existing network… dismounts and forward deploys, remaining wirelessly connected – common embedded IT platform and common docking platform across all DoD CBRN sensors

Desired Capabilities - Data and Service Standards

- Out of the box, the sensor should be seen on the network as a discoverable web-enabled service
  - Light weight web-server available via HTTP(S)
  - Over-the-net administration, maintenance, analysis and in-the-field reconfiguration
  - URL / network configuration for streaming data or WSDL exposed for applications to pull data
  - Configuration of xmit of any/all available data fields and period of transmission
  - Repurposing of sensor data and software
  - Configuration (just like most $30 routers) such that email address(es) can be specified for log dumps, providing notification / request for service, or quality of service issues, or denial of service attacks

Desired Capabilities - Data and Service Standards

- Non-proprietary interface that accepts and generates XML to a well-formed schema
  - For JPEO-CBD developed sensors, this is the CBRN XML Schema
  - For commercial developers:
    - If the commercial sensor interface supplies a schema, then we write an XSLT (at a minimum) to map data from sensor vendor schema to CBRN XML Schema (ability to download an XSLT to the sensor preferred)
    - If the commercial sensor interface does not support a well-formed schema, then we will have to write a driver to their vendor supplied interface and then convert that data into a CBRN XML Schema representation *(this is the case we want to avoid at all costs and is a last resort… it's where we are today)*

Starting with common standards in S&T makes it much easier to evaluate new technology and transition it into programs of record.

Desired Capabilities - Reusable Host Platform

- Handheld CBRN sensors built to a common physical hardware docking specification
  - For power/recharge and wired network access when docked
  - Sensor remains wirelessly connected undocked and battery powered
- For those familiar with the JWARN JCID… we want "JCID on a chip", embedded into all future CBRN sensors…
  - Seeking common small, cheap, proven, low-power hardware platforms (system on a chip or similar) that can be embedded in every sensor to host the desired software capabilities
  - Embed a smart network interface component into sensors
  - Same IT platform can be shared across CBRN sensors

Desired Capabilities - Modular Components

- Completely abstract the “GIG” interface component from the rest of the sensor platform
  - Reuse the infrastructure (software, embedded network cards, etc.)
  - Sensor vendors focus on CBRN “sensing” (detection and identification) and reuse components that provide data availability, sensor services, and security models
- Common open standard software drivers to communicate with devices and code/decode their data to/from the extensions that would be made to the CBRN COI XML Schema
- Performance - ability to “plug-in” compression / decompression on a data stream. Hooks available that allow us to download new modules that can change how that compression / decompression is performed (or not) based on bandwidth / environment

Desired Capabilities - Security

- Ability to "plug-in" encryption / decryption on a byte stream (XML). Hooks available that allow us to download new modules that can change how that encryption / decryption is performed (or not) based on bandwidth / environment
- Ability to "plug-in" future "XML Software Based Guards" into the sensor – hooks available to send / receive data cross-domain
- Encapsulates embedded information assurance framework that contains critical security related software that can be leveraged by all platforms without each of them having to worry about the IA details (abstracted security layer between the software and all ports, protocols, registry settings, network access)
- XML (tagging) of data to support a progression toward Multi-Level Security (MLS) and attribute level discrimination

Encapsulate and reuse accredited IA modules!

Conclusion - Example

- Adding a CBRN Sensor to the Network Should be NO HARDER THAN adding a wireless network printer:
  - Buy printer
  - Power on printer
  - Put CD in my computer
  - Load printer driver
  - Automatically discover new printer
  - Start printing… in less than 15 minutes after opening the box!
- Printer status and control automatically integrate into my host platform printer service manager
- From any where I have access to the network, I can get printer status, print, reconfigure the printer, and update software on that printer that provides new capabilities…

The "network components" are cheap, small, flexible, and available… and, they need to be reused and encapsulated in CBRN sensors!

Conclusion

An average 10-year old should be able to connect / configure / use CBRN sensors… and the steps for connecting to the network and "going mobile" should be identical across CBRN sensors!

Next Generation Modeling of Operational Effects

Maj William Greer
AFRL HEPC

Next Generation Models
CB Effects on Military Operations

Objective: Extend and improve the CBRN warfare effects on military operations methodologies and transition demonstrated technologies to the Joint Operational Effects Federation (JOEF) program

Areas of effort:

- Represent new operational and threat domains
  - **Mobile Forces Operations (such as Army and USMC units)**
  - **Toxic Industrial Chemicals/Materials (TICs/TIMs), nuclear effects and radiological operations effects**
- Improve decision support capabilities
- Improve and automate modeling of critical CONOPS / Course of Action Analysis and performance factors
- Improve analytical utility by enhancing post-processing capabilities

New Operational Domains – Mobile Forces

- Short-term development efforts to support JOEF Increment I Initial Operating Capability (IOC)
  - Convoy modeling for chemical threats
  - Conversion and integration of existing task network datasets from Army combat simulations
  - Other support TBD
    - Relevance, capability and maturity of current mobile forces applications will be assessed before any development begins
- Longer-term development efforts to support later increments of JOEF
  - Emergent behavior modeling
  - Exploring theater level modeling

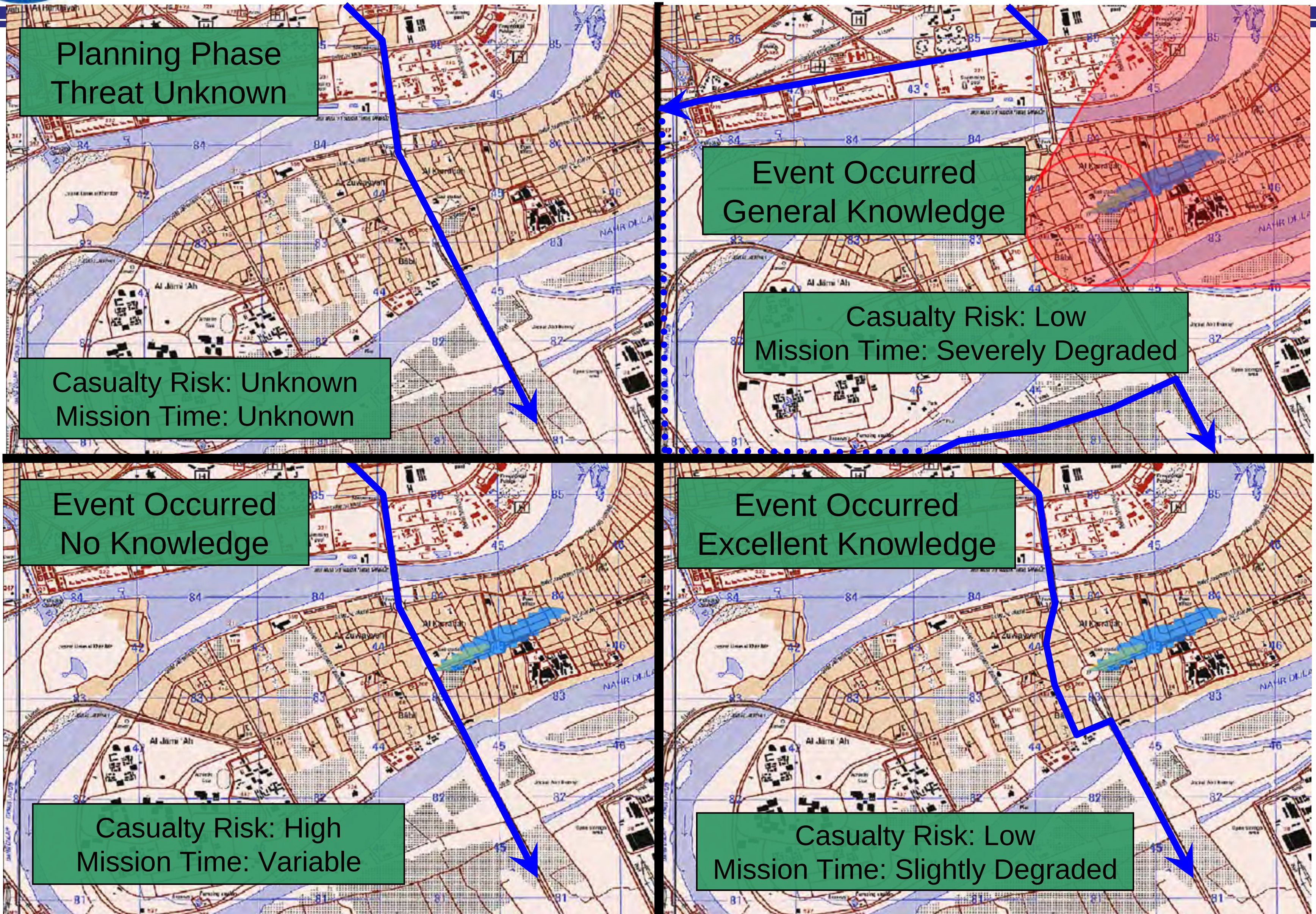
Mobile Forces and CBRN M&S Status

- Fairly Robust Capability
  - **Macro-level physics-based models**
  - **Semi-empirical models**
  - **Deterministic and stochastic processes**
- Some Capability
  - **Human physiology**
  - **Situation awareness**
  - **Toxicology**
- Minimal or No Capability
  - **Soft factors**
  - **Human cognition and decision processes**
  - **Integrated stressor and casualty mechanism effects**
  - **CBRN within broader operational context**

Mobile Forces –
Convoy Encounters Chemical IED

- Analytic Objective: quantify value of varying knowledge about the CW hazard to mobile forces
- Knowledge variants:
  - **Precise definition of contamination with dynamic updates**
  - **No knowledge**
  - **ATP-45 hazard warnings areas**
- Operational Options
  - **Ignore hazard**
  - **Perform recon and adjust appropriately**

Convoy Analysis – Knowledge Based Courses of Action

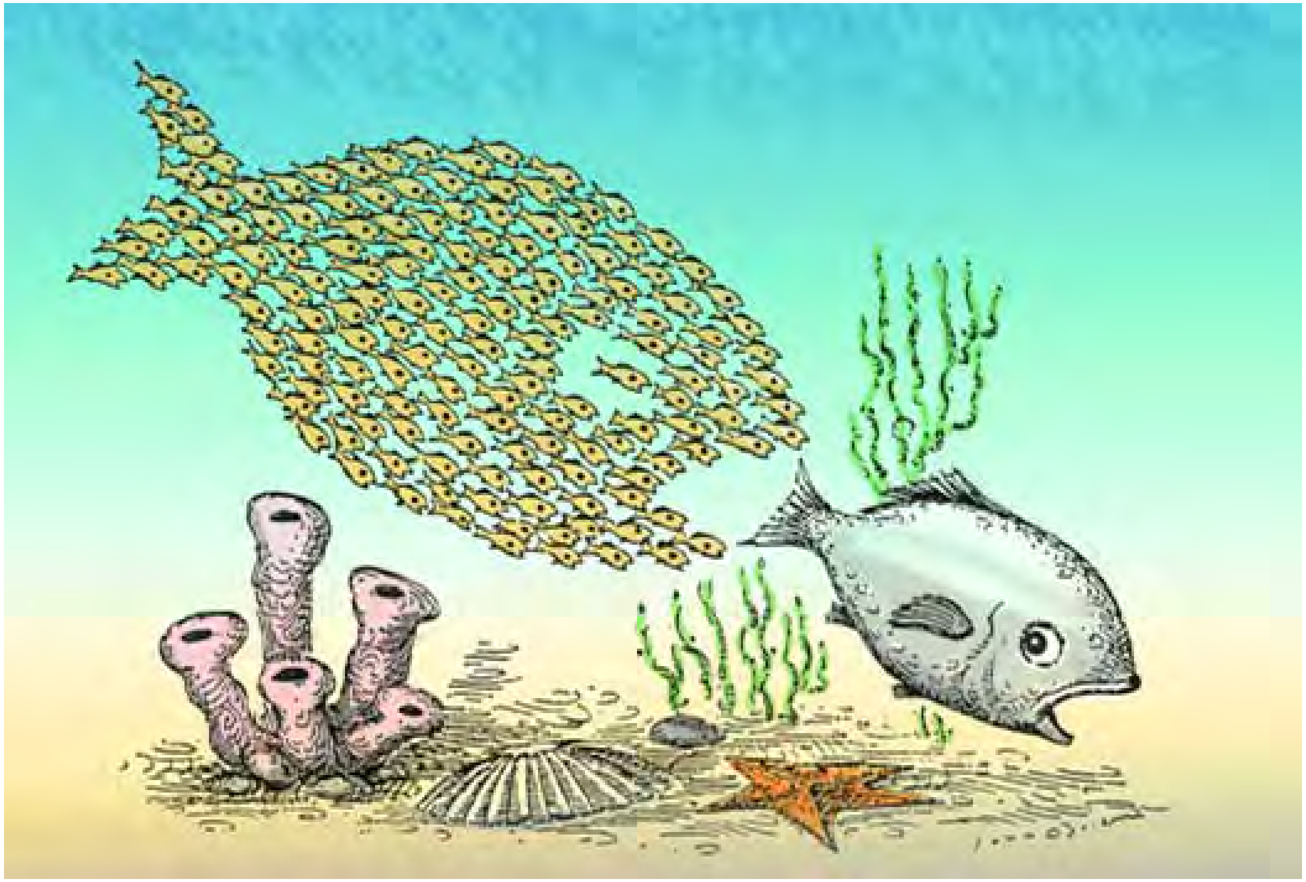


New Operational Domains – Analysis is Evolving

- Next generation models must consider expanding mission roles:
  - **Urban operations and complex environments**
  - **Close "contact" as well as close combat**
  - **Asymmetric threats**
- Next generation tools must must provide integrated representation of multiple challenging factors:
  - **"Fog of War" - uncertainty and error**
  - **Stressors and enhancers**
  - **Environmental effects**
- Operational analysis requires a paradigm shift to address these challenges
  - New fundamental ways of modeling may assist in solving these problems

New Operational Domains – Emergent Behavior

Emergence happens when many simple things combine to form unexpectedly complex results.

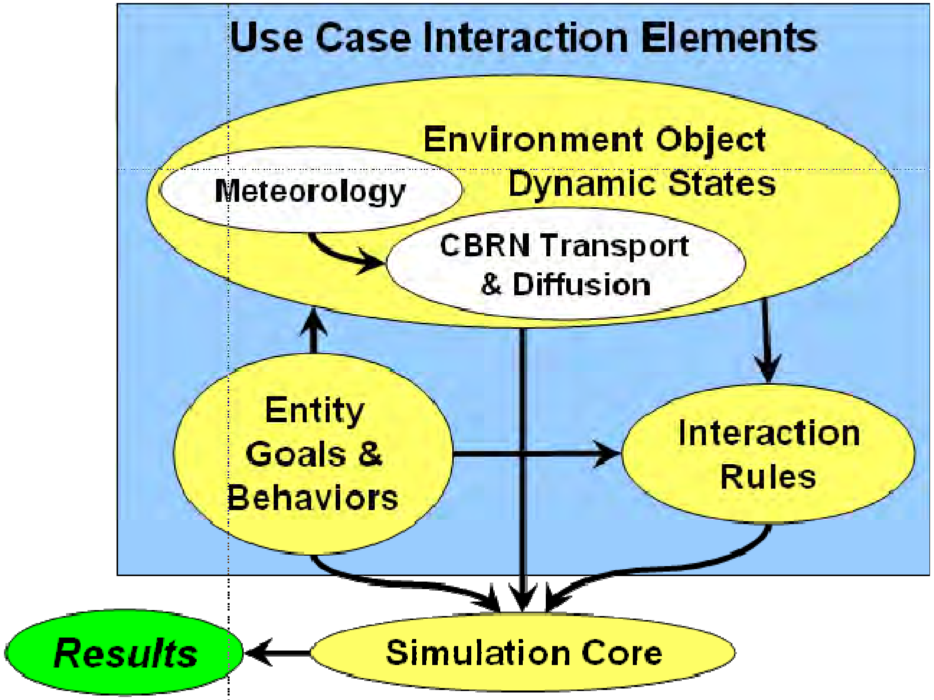


From Xerox Palo Alto Research Center
Dynamics of Computation Area

New Operational Domains – “Emergent Analysis” Approach

- The “emergent” paradigm will supplement rather than replace current methodologies
- Approach is not model specific
  - The STAFFS simulation model chosen for proof of concept

Emergent Analysis Functional Approach



1. **Generate multi-disciplinary use cases/scenarios reflecting analytic objectives**
2. **Define critical scenario elements in terms of interactions between subsets of:**
   - **Operational environment objects**
   - **Simulation entities**
3. **Implement in Simulation of Choice**
4. **Run many replications**
5. **Distill results**

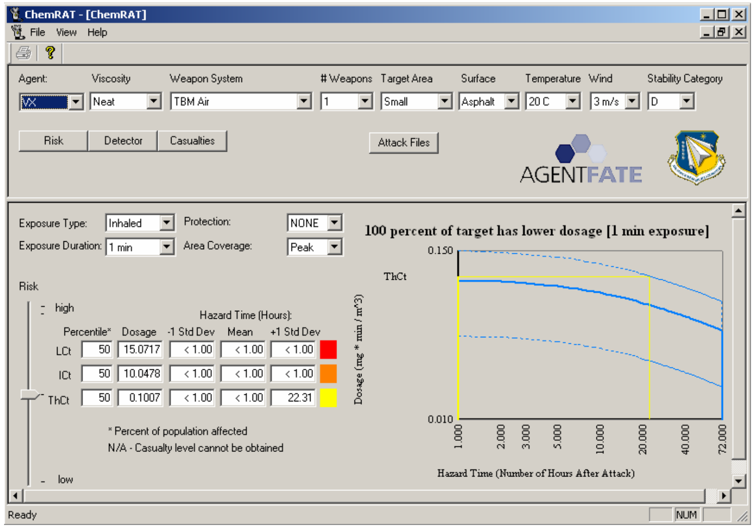
New Threat Domains – TICs/TIMs, Radiological & Nuclear

- TICs/TIMs modeling and dispersion will be handled by existing interfaces to T&D models
  - New Ops Effects modeling will required due to large changes in volume of challenge, duration of release, and human response
- Suitable blast, thermal, electromagnetic pulse, particulate dispersion and radiological effects model will be selected in short term
  - Eventually these effects will be provided by the Joint Effects Model (JEM)
- Electromagnetic pulse and radiological effects may be difficult to model and quantify in terms of an operational effect

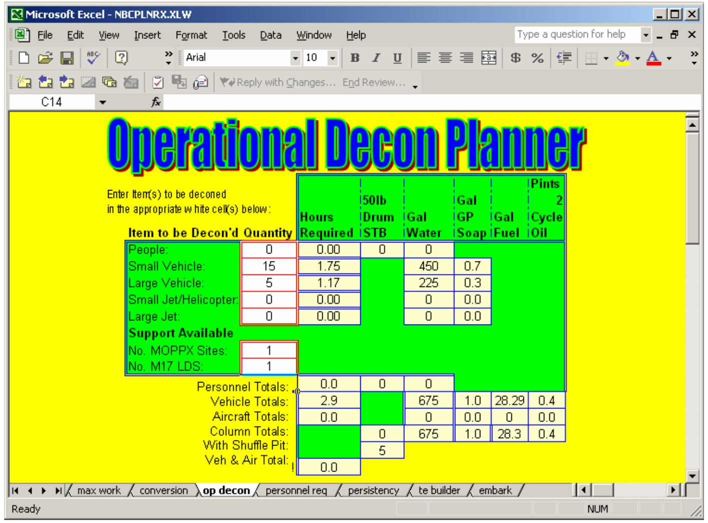
Improving Decision Support – Decision Tool Development

Objective: Provide easy-to-use tools that the warfighter will use real-time when situation specific CBRN questions arise

- Usability will be similar to the Chemical Hazard Estimation Method Risk Assessment Tool (CHEMRAT) and NPC Calculator tools
- Short execution, training and setup times critical to success|
- Output must be situation specific and reliable



CHEMRAT

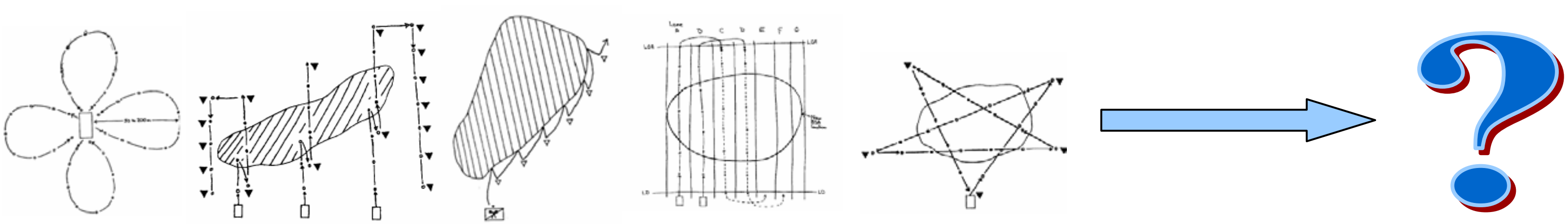


NBC Calculator

Improving CONOPS Modeling and Course of Action Analysis

- **Most planning activities take place given a fixed and well defined set of behaviors and a ‘limited’ number of solutions**
  - Task network modeling works well to address concerns for these problems
- **Other planning support can have numerous to infinite ways to solve a problem**
  - In the CB modeling, many of these activities are related to CB CONOPS and courses of actions
  - Traditionally to support specific and ground-up CB CONOPS development, new code would need to be written
- **This effort will minimize development required to do tailored, analysis of CB CONOPS development and Course of Action Analysis**

Existing NBC Reconnaissance Search Patterns **New Urban Search Plan?**

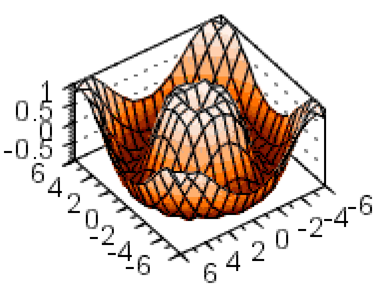


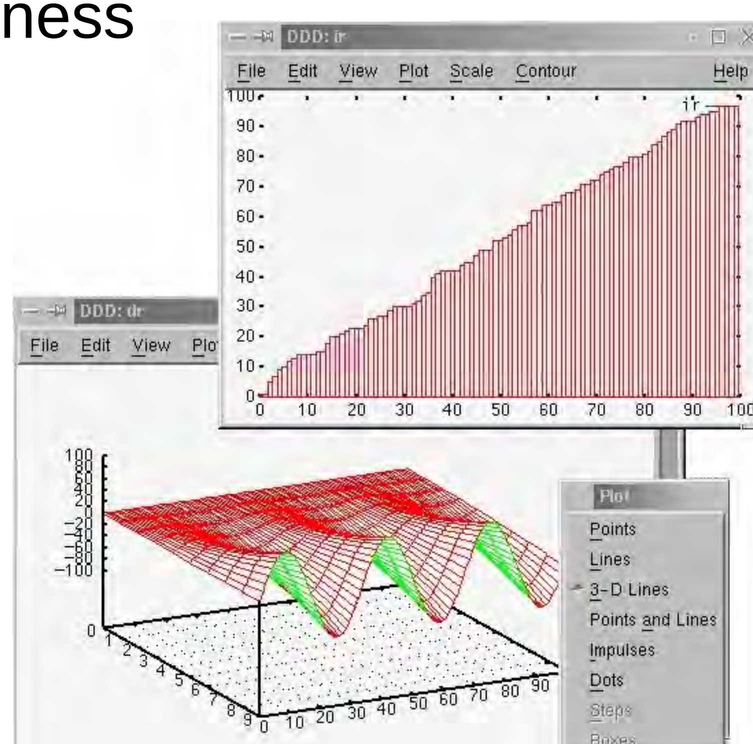
Development support for new plans should not require significant coding efforts every time a new plan is proposed

Figures taken from FM3-19

Enhancing Post-processing Capabilities

- Large simulations produce massive amounts of data
- In its raw form this data is generally difficult to navigate and understand
- Post-processing capabilities will assist in searching data for relevant Measures of Effectiveness
- This data will displayed in formats relative to the uses of the simulation models





Conclusion

Next Generation Models will advance the state of CBRN modeling and simulation technology and will produce products that will support the JOEF acquisition program

Backups

Next Generation Model of CB Effects on Military Operations

Objective: Extend and improve the CBRN warfare effects on military operations methodologies and transition demonstrated technologies to the JOEF program

Description of Effort: Four thrusts are planned.
1. Represent new operational and threat domains, including mobile force operations (such as Army and USMC units), conventional and radiological attacks, and additional aircraft types. 2. Update the supporting database and improve modeling of: critical CONOPS/Course of Action Analyses and MOPP encumbrance. 3. Create a human-in-the-loop (HitL) training capability. 4. Improve the analytical utility by enhanced post-processing capabilities.

Benefit to Warfighter: The improved analysis/decision support capability will increase the relevancy and applicability to operational users and will support improved decision-making through the application of proven methodologies. The enhancements for training will allow warfighters to explore and prepare for the unique challenges of operating in a CBRN environment.

Challenges: Finding the right balance between complexity and usability as well as between fidelity and run-time. Obtaining applicable datasets for development and testing.

Maturity of Technology: TRL 3 & 4

Capability Area: M&S/Battle Management (2.2.3)

Goals/Milestones by FY

FY05 Design new operational & threat domain methods

FY06 Start implementation of new methodologies
Develop methods for HitL and automated analysis
Construct and archive demonstration scenarios

FY07 Implement new operational models
Implement HitL and automated analysis
Integrate data from operational sources
Develop automated analysis interface

FY08 Develop training interface
Final testing and documentation
Refinement, demonstration and beta testing

Funding ($K):	FY05	FY06	FY07	FY08
6.2	300	1,500	2,000	2,000

PI Contact Information: PI contact info: Maj William Greer, (937) 255-2436, William.Greer@wpafb.af.mil

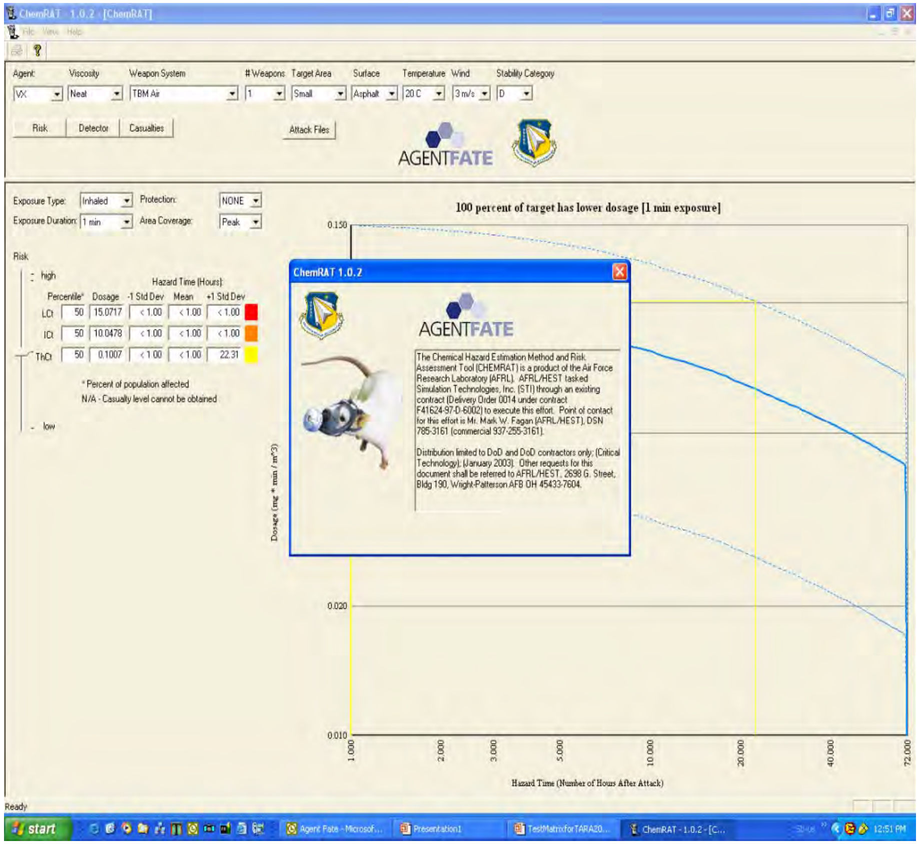
CHEMRAT and Updating Air Force Manuals 10-2602 & 10-2517

Maj William Greer

AFRL HEPC CBD

Decision Aiding Analysis & Tools CHEMRAT

- **CHEMRAT initiated by warfighter urgent need request**
- **Ver 1.0 Developed and fielded in 3 months**
  - **Released in Jan 2003**
  - **Deployed to OIF**
- **Interim accredited by DATSD-CBD in April 2003**
- **Transitioned to JOEF in FY05**
- **Currently used by USAF, USN, NORTHCOM, DHS, DOE**
- **Ver 1.5 to be released this quarter**



Decision Aiding Analysis & Tools AFMAN 10-2602 Table Updates

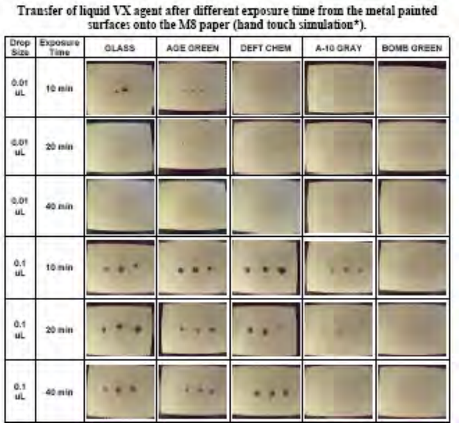
- **USAF guidance manuals being updated with revised hazard prediction tables**
  - **AFMAN 10-2502**
  - **AFMAN 10-2517**
- **Estimates derived from updated VLSTRACK predictions**
- **Incorporates newest agent fate data**
- **Scheduled release in Dec 2005**

Vapor Hazard VX On Concrete ECt 16

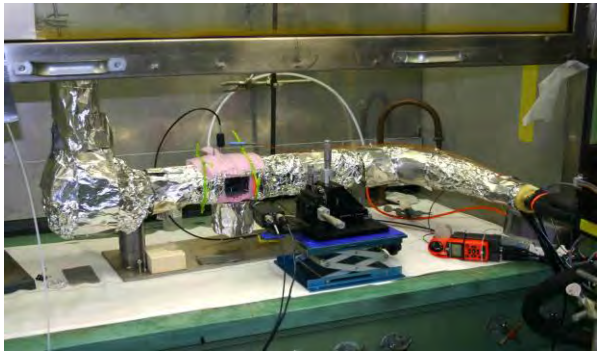
		Stability		PSC D	PSC F	PSC D	PSC F	PSC D	PSC F
		Wind Speed (knots)		2		6		10	
Agent	Release	Munition	Temp °C (°F)						
VX	Low Alt.	TBM	-5 (23)	0.21	0	0.0	0	0.03	0
VX	High Alt.	TBM	-5 (23)	0	0	0.0	0	0	0
VX	Low Alt.	TBM	10 (50)	24.0	16	0.49	0	0.3	0.1
VX	High Alt.	TBM	10 (50)	9	0	0	0	0.1	0.0
VX	Low Alt.	TBM	25 (77)	72	72	3.57	1.5	1.88	0.9
VX	High Alt.	TBM	25 (77)	72	20	4.6	0.43	0.6	0.22
VX	Low Alt.	TBM	50 (122)	72	72	56.19	72	45.19	22.19
VX	High Alt.	TBM	50 (122)	72	72	43.19	16	7.8	13.5

Decision Aiding Analysis
Revised C-CW CONOPS and TTPs

- **Leveraged live agent outdoor tests to quantify and assess detection levels of:**
  - **CAMs**
  - **M-22 ACADAs**
  - **M-8 paper**
  - **M-256A kits**
  - **HAPSITE**
  - **M-279 surface sampler**
- **Determine droplet spread factors**
- **Quantify transfer of liquid agent by vehicles**
- **Determine effectiveness of foot/glove decon procedure**



Transitioning CW Agent Fate S&T Into Products For CBDP Users



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		Stability		PSC D	PSC F	PSC D	PSC F	PSC D	PSC F
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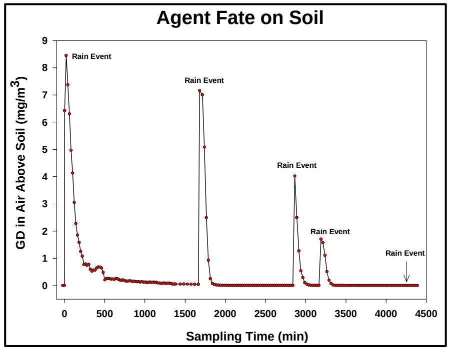
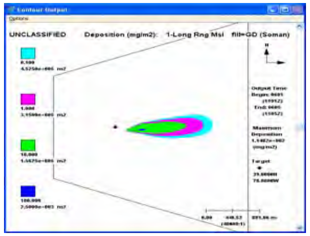
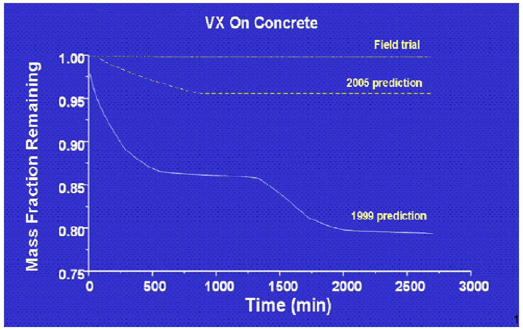


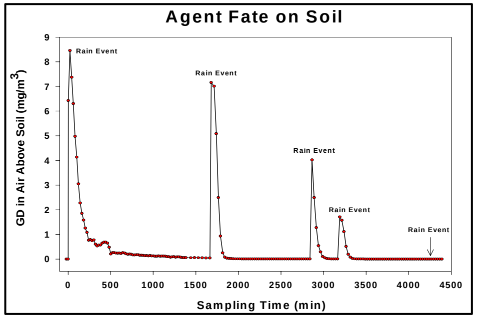


Agent Fate Program Products

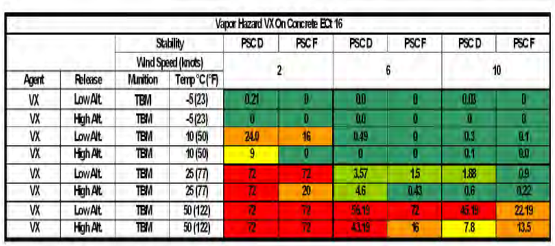
CHEMRAT 1.0
CHEMRAT 1.5



New version of VLSTRACK
(June 2004)



Rain event added to
AFMAN 10-2502 & 10-2517
(Dec 2005 release)



Vapor Hazard VX On Concrete ECt 16									
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AFMAN 10-2502 & 10-2517
Vapor hazard persistence
tables updated
(Dec 2005 release)

Publications on agent fate
(technical reports, scientific
papers, etc.)

C-CW CONOPS & TTPs

Questions?

Chemical Homeland Security System

C-HoSS

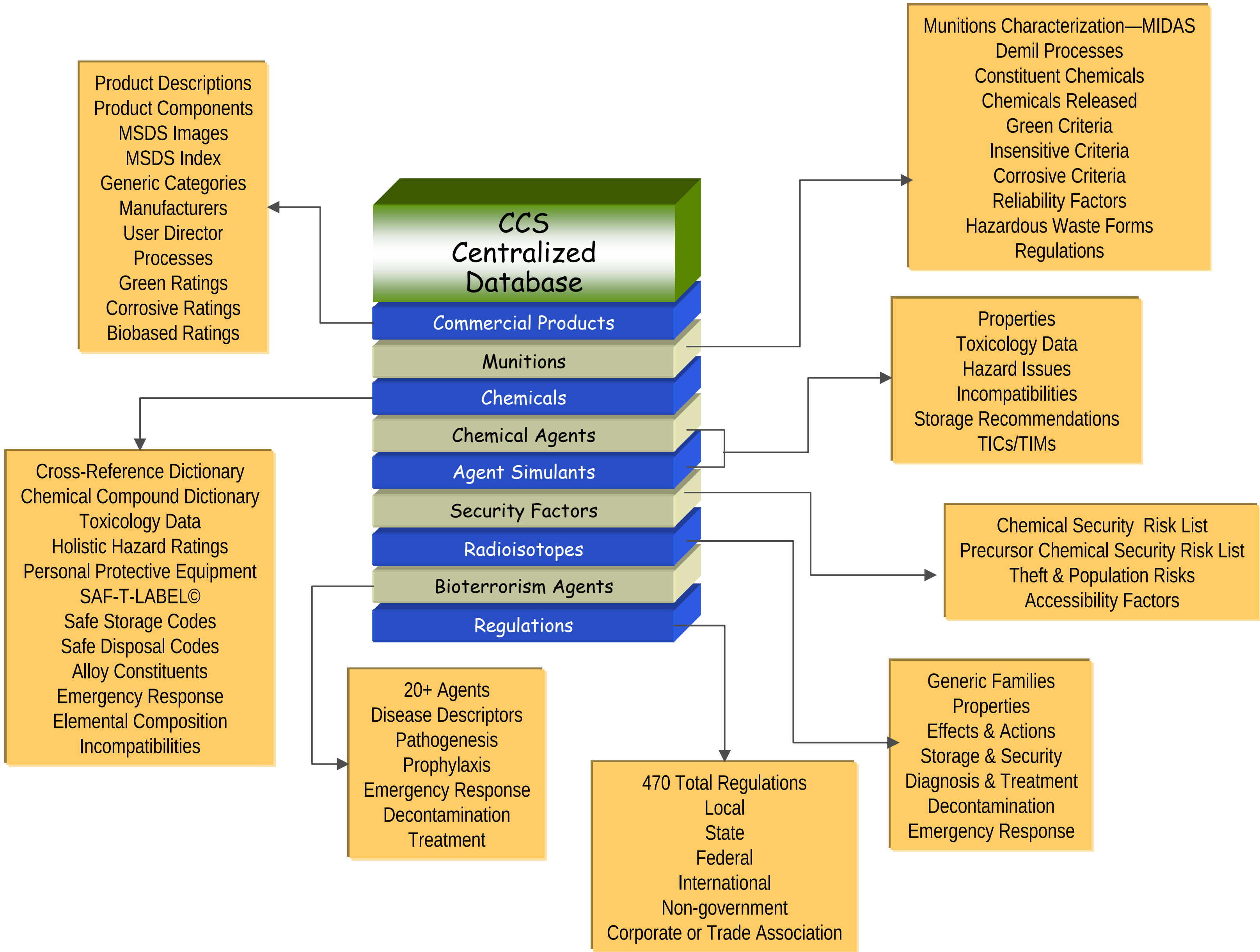
Chemical Compliance Systems, Inc.

706 Route 15 South, Suite 207 • Lake Hopatcong, NJ 07849

973-663-2148 • (fax) 973-663-2378

www.chemply.com

The CCS "Core" Database



Regulated Hazardous Chemicals

Acute Hazard Orientation

Chemical Agents
Neurotoxins
Extreme
Toxins
Radioactives
Explosives
Shock Sensitives
Corrosives
Flammable
Oxidizers
Hazardous Air Pollutants
Persistent Bioaccumulative Toxins
Priority Pollutants

Chemical Security Risks List

ACGIH
DEA
DOT
EPA
OSHA
California
Iowa
Maryland
Nevada
New Jersey
European Community

CPSC Specialty Regulated Substances
Canada Export Control Lists
DEA Essential Chemicals
DEA Precursor Chemicals
DOC Export Restrictions
EU Black/Gray Lists
IATA Air Transport Forbidden
IATA Passenger Transport Forbidden
IATA Regulated Substances
UK The Red List (Water)
UN/FAO Prior Informed Consent

Precursor Chemical Security Risks List

Chemical Agents and Simulants

Properties
—Structure
—Chemical
—Physical

Toxicology Data
—Human
—Animal
—In Vitro

Hazards
—Protection
—Decontamination
—Persistence
—Use

Incompatibilities
—Chemical
—Conditions
—Containers

Storage Recommendations
—Container
—Conditions
—Distances
—HSAS[a] Variables

---

[a] HSAS = Homeland Security Advisory System

Toxic Industrial Chemicals/Toxic Industrial Materials (TICs/TIMs)

Selected Examples

Industrial Feedstocks:	Acrylamide, Chlorine, Hydrogen Chloride, Phosgene
Carbamate Insecticides:	Baygon, Mobam, Temik, Zectran
Organochlorine Insecticides:	Aldrin, Dieldrin, Endrin, Lindane, Heptachlor
Organophosphate Insecticides:	Disulfotan, Mevnphos, Parathion, Methylparathion
Insecticide Synergists:	Piperonyl Butoxide
Fungicides:	Pentachlorophenol, Hexachlorobenzene, Maneb, Naban, Zineb
Fumigants:	Calcium Cyanide, Methyl Bromide, Phosphine
Seed Disinfectants:	Methylmercury Acetate, Methylmercury Cyanide

GOALS: [1] Identify all chemicals with severe to extreme acute toxicity
[2] Identify all chemicals in product classes with similar mechanisms of action

Incompatible Chemical Database

Chemical Class	Chemical	Incompatible Chemical	I.C. Class	Interaction Hazard
Corrosives	Acetic Acid	Hydrogen Peroxide	Oxidizer	Explosion
	Nitric Acid	Acetylene	Flammable	Explosion
	Chlorine	Aluminum Powder	Metal	Spontaneous Fire
Flammables	Acetone	Chloroform	Carcinogen	Explosion
	Benzene	Chlorine	Corrosive	Explosion
	Carbon Disulfide	Potassium	Flammable	Violent Explosion
Reactives	Nitrotoluene	Sulfuric Acid	Corrosive	Explosion
	Nitroethane	Hydrocarbons	Combustible	Explosion
	Acrylonitrile	Bromine	Corrosive	Explosion
Products	Toilet Bowl Cleaner	Metal Powders	Metals	Explosion
	Bleach	Ammonia	Product	Poisonous Gas
	Paint Solvent	Chloroform	Carcinogen	Explosion

Chemical Security Procedures

Security Procedure Phases

Phase I	Vulnerability Assessment *Identify chemical hazards, security risks, mortality risks*
Phase II	Countermeasures Implementation *Reduce vulnerabilities*
Phase III	Verification Audit *Independently confirm counter measure adequacy*
Phase IV	Management System Integration *Integrate chemical security procedures into line management functions*

C-HoSS Security Criteria and Standards

- Chemical Hazard Class Rankings (*by Hazard Class*)
- Chemical Hazard Grades (1-4) (*within each ranking*)
- Product Concentration Grades (1-4)

Chemical Hazard Factor (CHF) = Ranking × Grade × Concentration

- Theft Risk Grades (1-4) (*per product*)

Chemical Security Risk Factor (CSRF) = Ranking × Grade × Concentration × Theft Risk

- Population at Risk Grades (1-4)

Chemical Mortality Risk Factor (CMRF) = Ranking × Grade × Concentration × Theft Risk × Population Risk

- Accessibility Factor Levels (*Storage Constraint Levels and Descriptors*) (0.5 - 4.5)

CMRF × Accessibility Factor (AF) = Vulnerability Factor (VF)

C-HoSS Security Risk Assessment Analytical Reports

PRECURSOR CHEMICAL ANALYSES

Precursor Chemicals by Location
Precursor Chemicals by Container Size
Precursor Chemicals by Weight
Precursor Chemicals Hazard Classifications [b]
Precursor Chemicals Hazard Rankings
Precursor Chemicals Hazard Grades
Precursor Chemicals Hazard Factors
Precursor Chemicals Security Risk Factors
Precursor Chemicals Accessibility Factors
Precursor Chemicals Accessibility Levels/Storage Codes

PRODUCT & CHEMICAL ANALYSES

Inventory by Product Type [a]
Product by Location
Product by Container Size
Product by Weight
Product Hazard Classifications
Product Hazard Rankings
Product Hazard Grades
Product Hazard Factors
Product Security Risk Factors
Product Accessibility Factors
Product Accessibility Levels/Storage Codes
Chemicals by Product
Pure Chemicals by Location
Pure Chemicals by Weight

SPECIALTY MODULE ANALYSES

Air Releases
Water Contaminants
Toxics
Pesticides
Hazardous Waste
Solid Waste
Storage Tanks
Munitions
Chemical Safety
Industrial Hygiene

INCOMPATIBILITY ANALYSES

Prioritized Incompatibility Threats by Product
Prioritized Incompatibility Threats by Room
Prioritized Incompatibility Threats by Building
Prioritized Incompatibility Threats by Facility

SECURITY ANALYSES

Inventory by CHF
Inventory by CSRF
Inventory by AF
Inventory by Storage Levels
Inventory (shift) by HSAS

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[a] Chemical, Precursor Chemical, Munition, Chemical Agent, Simulant.
[b] Assigned by their worst classification: (1) innate classification, or (2) reaction product classification.

C-HoSS Capabilities *vs.* Chemical Security Procedures

Security Procedure Phases	C-HoSS Capabilities
Phase I Vulnerability Assessment *Identify chemical hazards, security risks, mortality risks*	Chemical Hazard Factor Report Chemical Security Risk Factor Report Chemical Mortality Risk Factor Report Chemical Vulnerability Risk Factor Report
Phase II Counter measures Implementation *Reduce vulnerabilities*	Accessibility Factor (Storage Constraint) Report (per chemical/material)
Phase III Verification Audit *Independently confirm counter measure adequacy*	Chemical Vulnerability Factor "Report Card" (to the local fire department)
Phase IV Management System Integration *Integrate chemical security procedures into line management functions*	Integration of C-HoSS w/ the chemical tracking system Daily C-HoSS correlation w/ the Homeland Security Advisory System

For information, contact:

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www.chemply.com

Impact Assessment Tool

Dr. Ben Swindlehurst, Dstl

Mr. Darrell Lochtefeld, Anteon Corporation

Mr. Andrew Solman, Dstl

Operational Research

1. Support technology and concept evaluation
2. Predict CB effects on personnel, equipment and operations
   - determine CB operational effectiveness
   - development of NBC operational requirements
   - support TTPs, doctrine and CONOPS development
3. Support BoI and BoR studies
4. Support real time operational decision making

We need to be able to answer questions such as these:

1. Should the military procure the networked bio-detection system A, B or neither?
2. What are the key assets of an airbase that need to be protected in the event of a CB event in order to maintain operations?
3. Is operational effectiveness achieved with better detection systems or better medical countermeasures?
4. How should the military react to a specific real time CB event?

Current Capabilities

- Fixed Site operational effects models
  - E.g. STAFFS
- CBR OR Tools
  - E.g. UK CBR Virtual Battlespace (VB)
- Combat Models
  - E.g. JSAF/OneSAF
  - JWARS

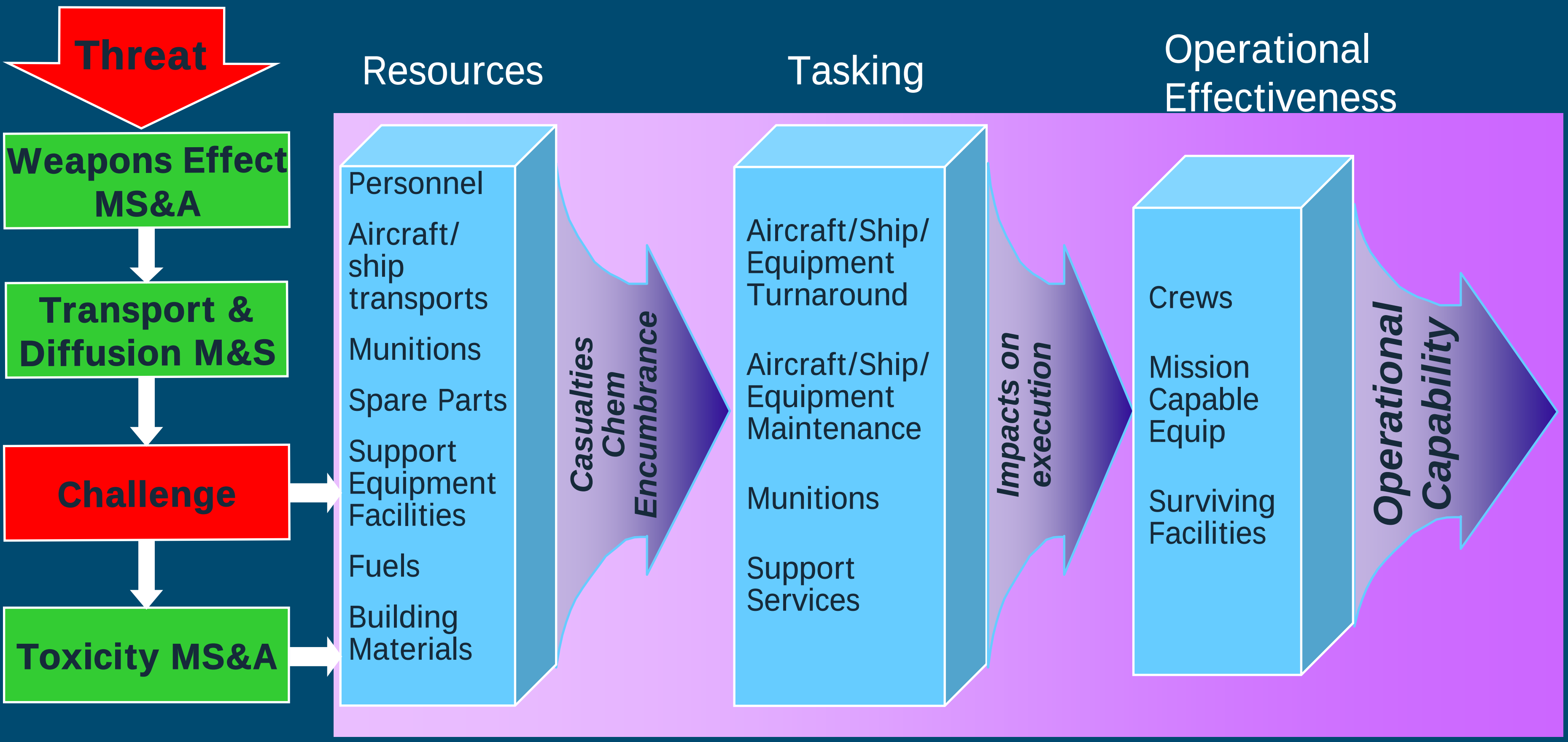
Background – STAFFS
(Simulation, Training, and Analysis For Fixed Sites)

- A DTRA CB sponsored Science and Technology developed program that calculates operational effects of WMD attacks on fixed sites
  - Solely government owned
- Transitioned to the Joint Operational Effects Federation (JOEF) program Sept 05
- A Monte Carlo system simulation
- High Level Architecture (HLA) compliant
- Complex data-driven model – primarily used by experienced analysts

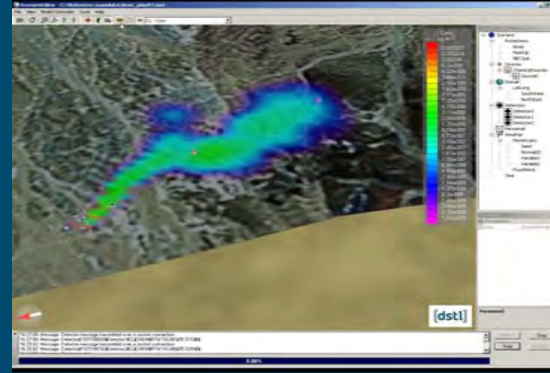
Background - STAFFS Modeling

- Capable of modeling operations at the individual resource level or at aggregate levels
- Two major fixed-site scenarios:
  - Fighter bases
    - Models major infrastructure, resources, and operations related to turning sorties for F16 and A10 aircraft
  - Aerial Ports of Debarkation (APOD)
    - Models major infrastructure, resources, and operations related to cargo throughput of an airlift operation
- Addresses all pillars of Chem-Bio defense

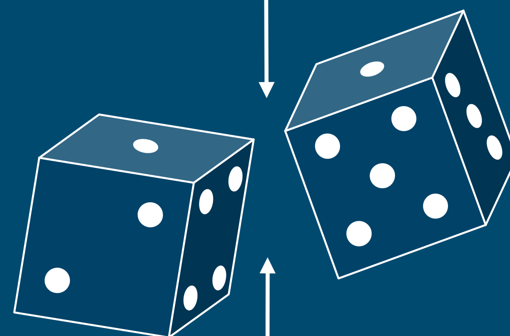
Background - STAFFS Methodology



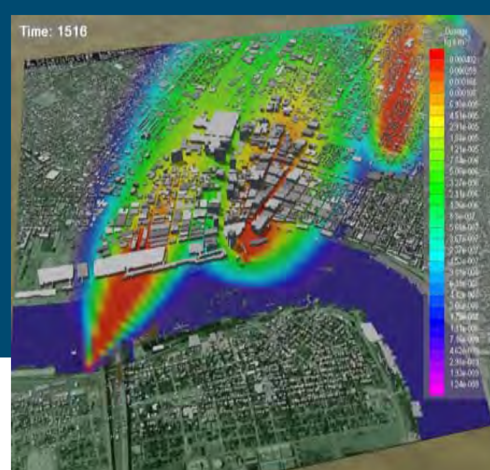
Virtual Battlespace



Modelling Application User Interface (MAUI)

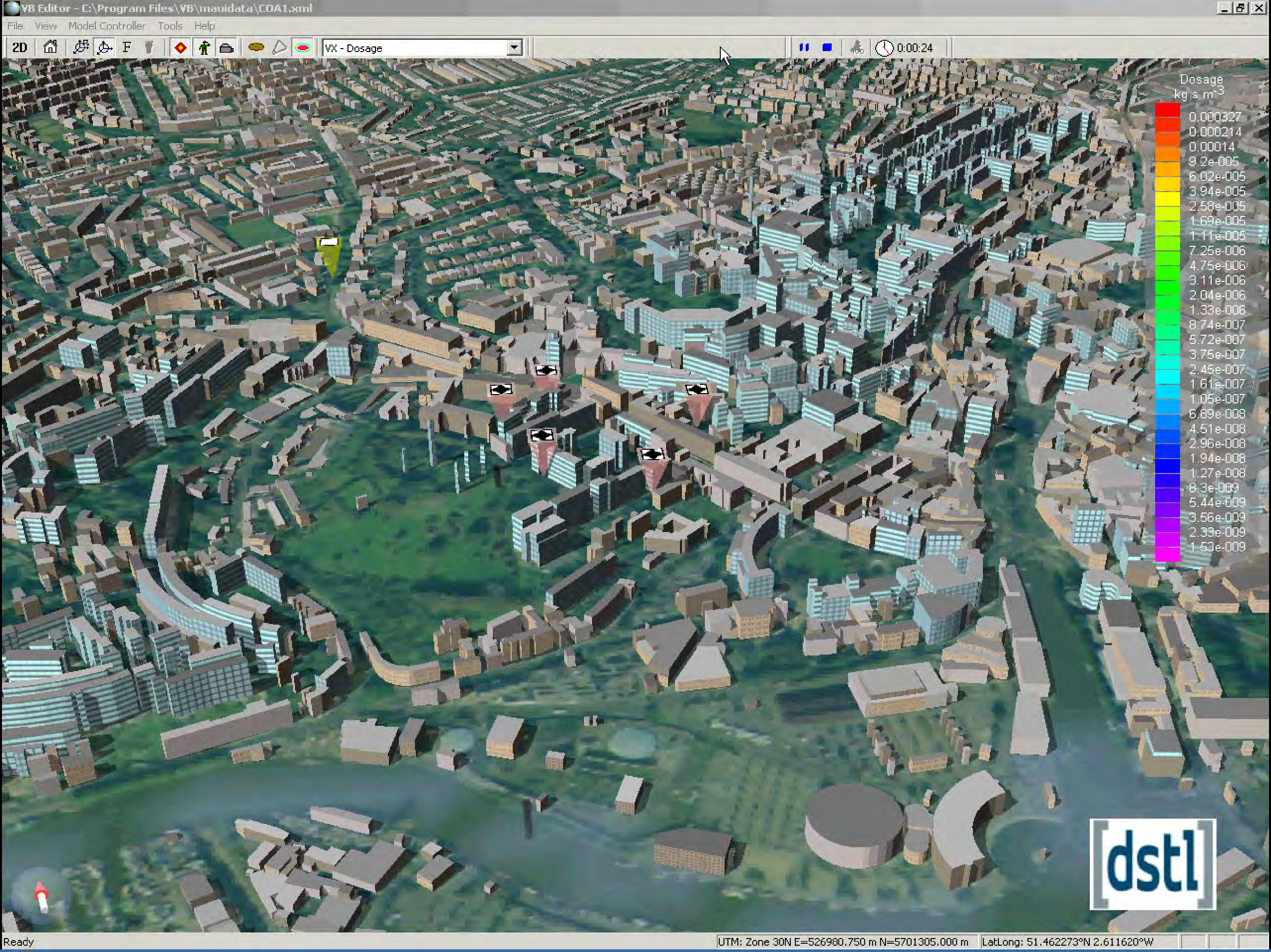


Monte-Carlo run controller



Synthetic Environment Modelling

Making the World Safer


VB Editor - C:\Program Files\VB\mauidata\COA1.xml
File
View
Model Controller
Tools
Help
2D
F
VX - Dosage
0:00:24
Dosage
kg s m-3
0.000327
0.000214
0.00014
9.2e-005
6.02e-005
3.94e-005
2.58e-005
1.69e-005
1.11e-005
7.25e-006
4.75e-006
3.11e-006
2.04e-006
1.33e-006
8.74e-007
5.72e-007
3.75e-007
2.45e-007
1.61e-007
1.05e-007
6.89e-008
4.51e-008
2.96e-008
1.94e-008
1.27e-008
8.3e-009
5.44e-009
3.56e-009
2.33e-009
1.53e-009
dstl
Ready
UTM: Zone 30N E=526980.750 m N=5701305.000 m
LatLong: 51.462273°N 2.611620°W

We need to be able to answer questions such as these:

1. Should the military procure the networked bio-detection system A, B or neither?
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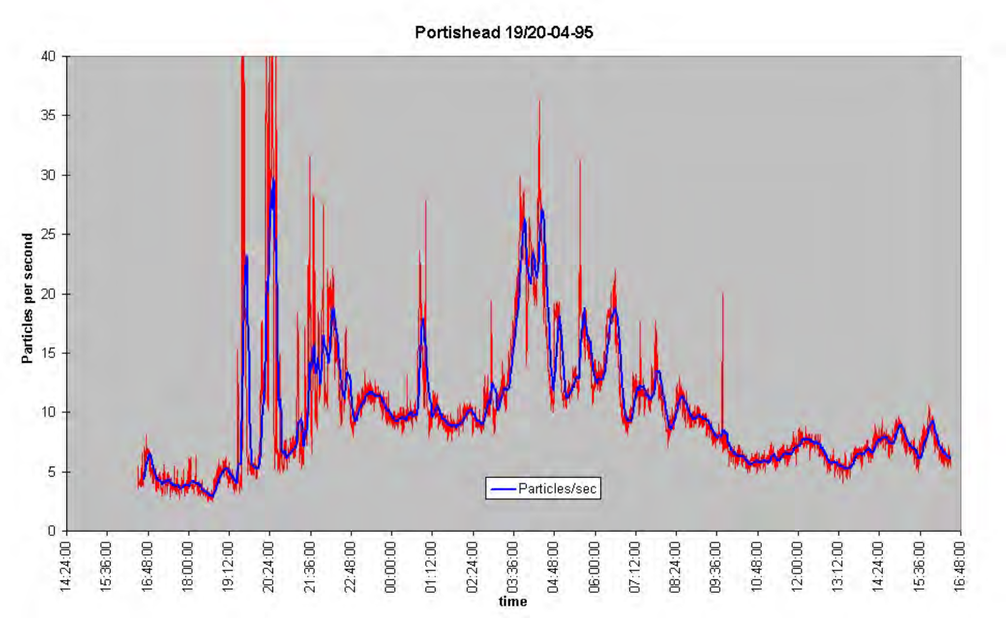
4. How should the military react to a specific real time CB event?

Application - ISMS procurement

- Dstl provided scientific support to procurement of an Integrated Sensor Management System (ISMS)
- Why?
  - ISMS aims to improve ability of biosensors to discriminate BW attacks from the natural aerosol background
- Dstl's contribution
  - To test two prototype systems using a realistic simulation, rather than field trials

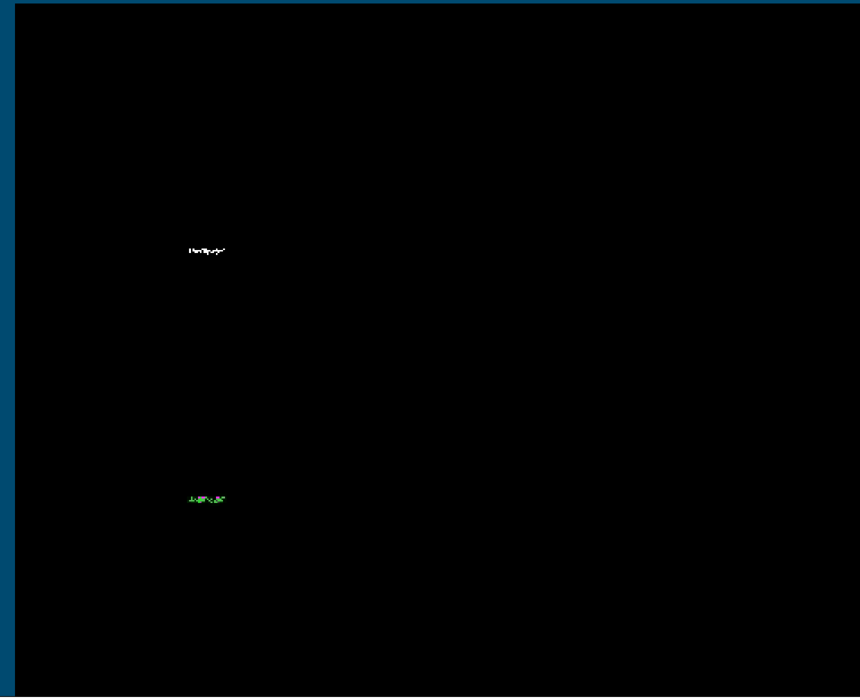


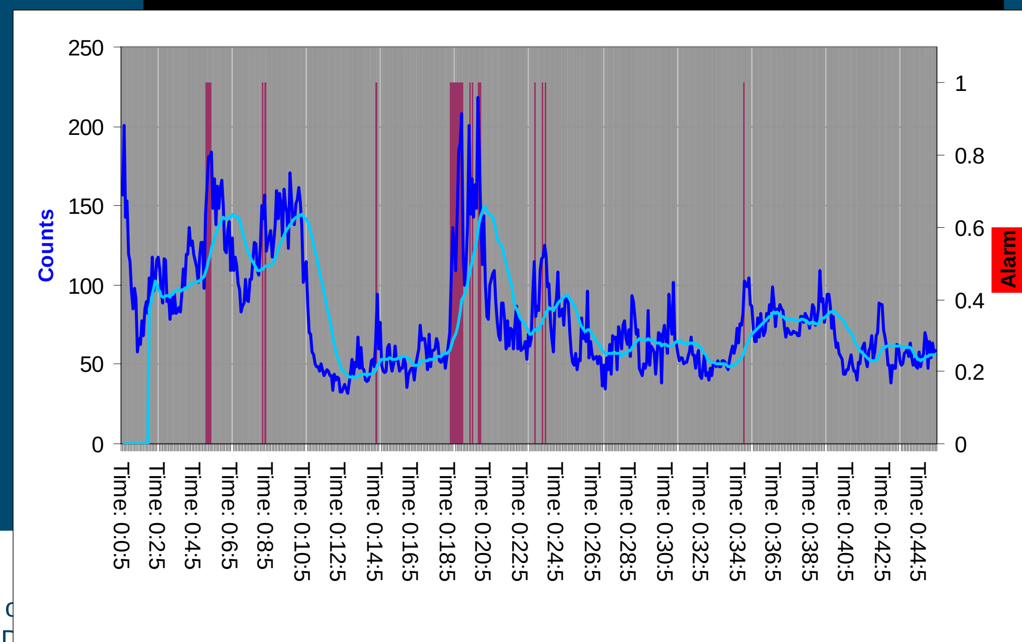
Particle number measured over

24 hour period at Portishead

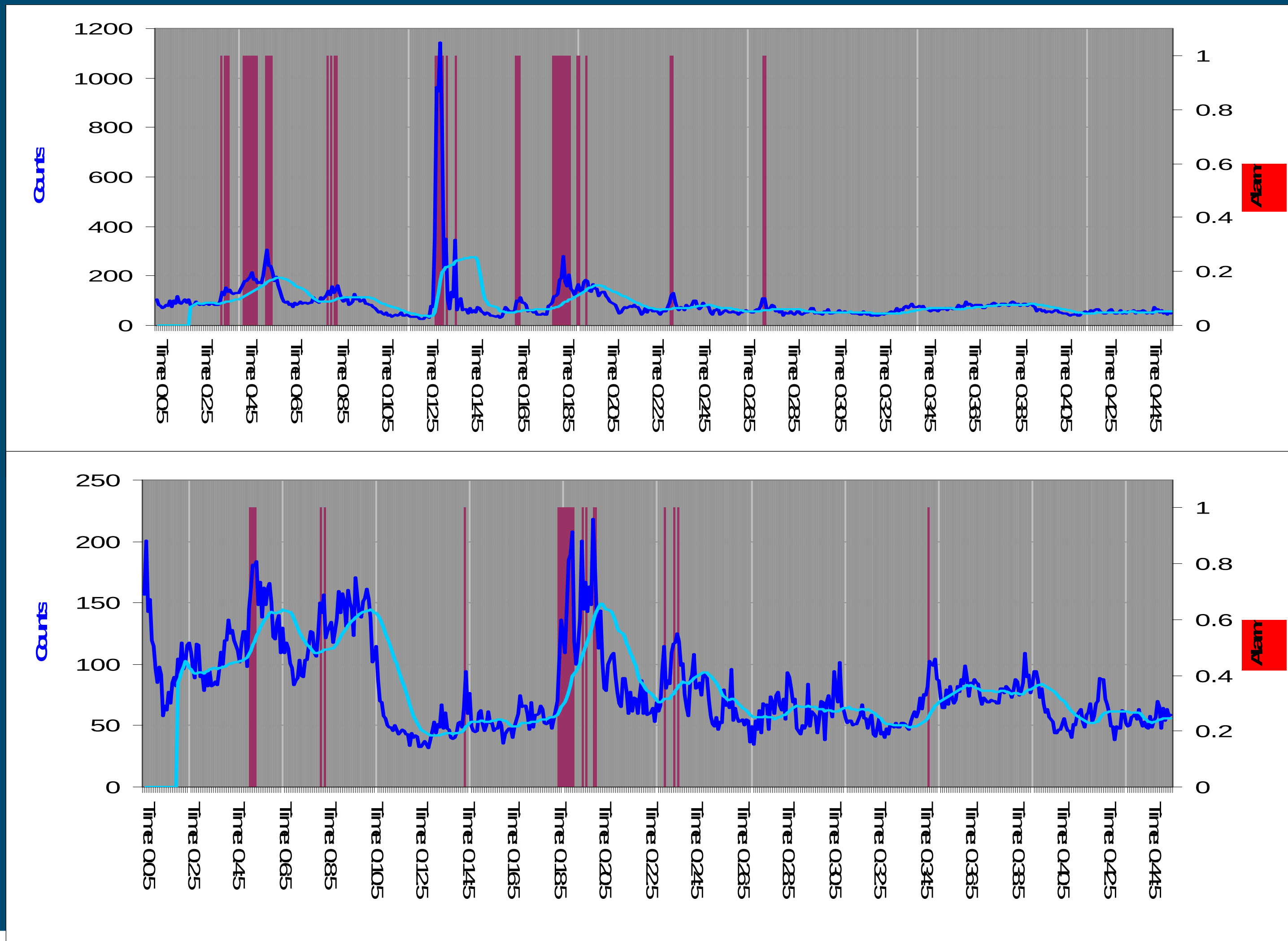
Models

- Meander turbulence model linked with UDM to provide a simulation of meandering plumes
  - required for realistic stimulation of detectors etc.
- Biological background model developed
  - based on field data
- Generic biological detector models developed
  - size, shape, fluorescence
  - include measurement noise and sampling noise





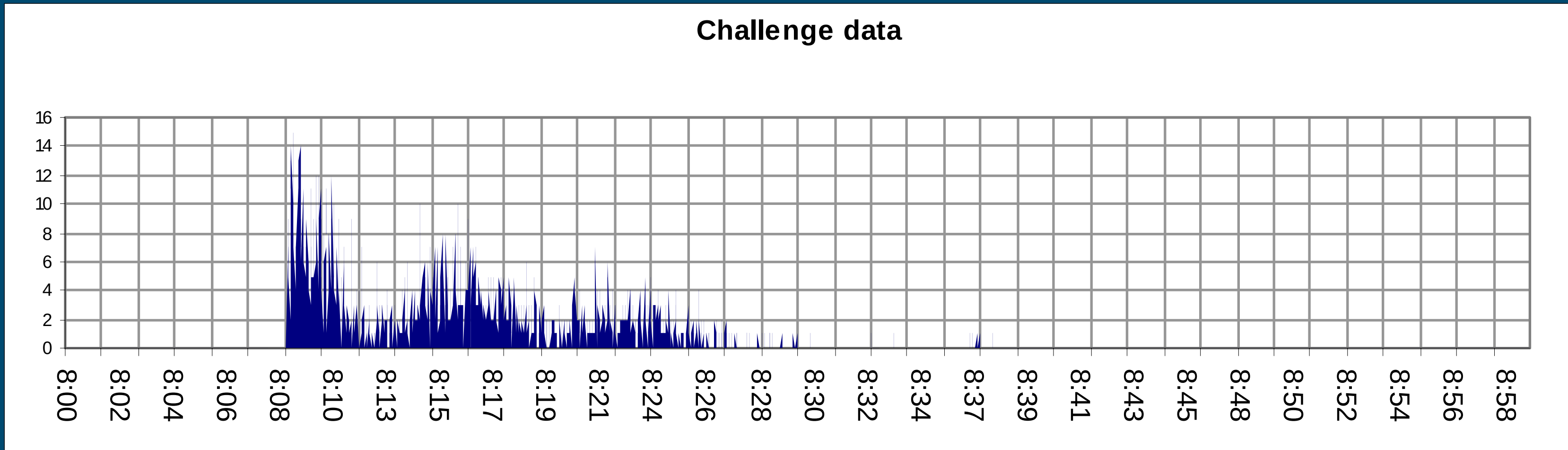
Application - ISMS procurement

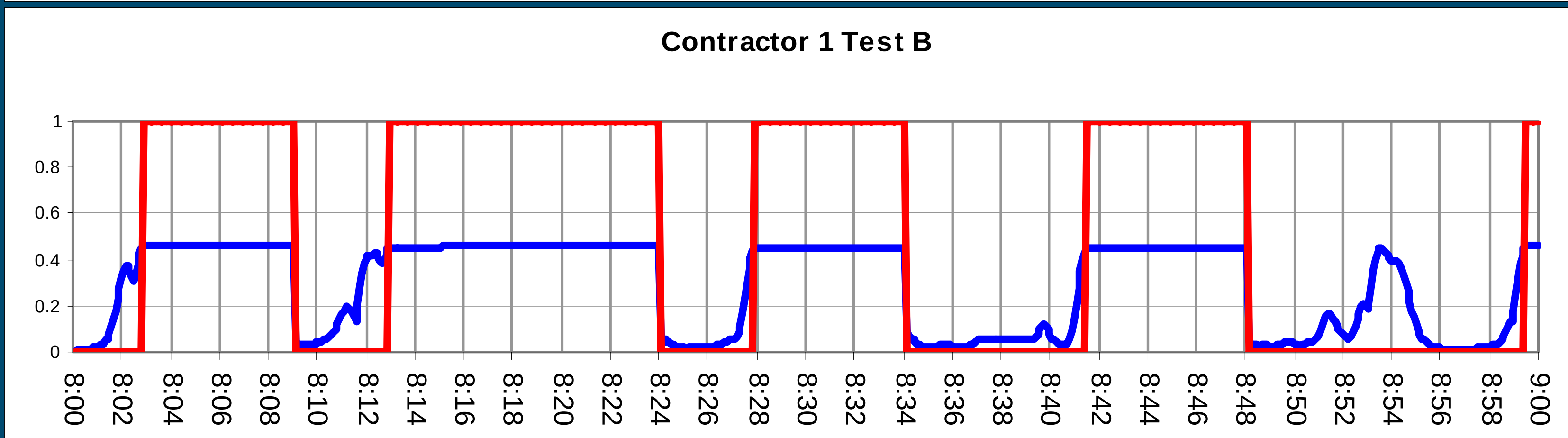


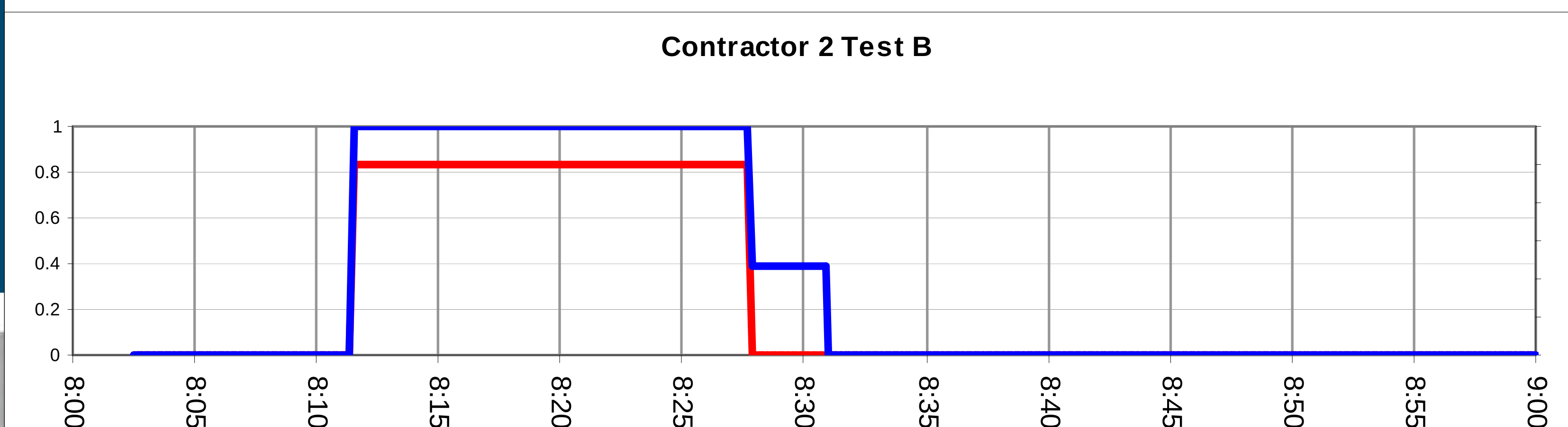
November 1, 2005

Dstl is part of the Ministry of Defence

Making the World Safer


Challenge data
16
14
12
10
8
6
4
2
0
8:00 8:02 8:04 8:06 8:08 8:10 8:13 8:15 8:17 8:19 8:21 8:24 8:26 8:28 8:30 8:32 8:34 8:37 8:39 8:41 8:43 8:45 8:48 8:50 8:52 8:54 8:56 8:58


Contractor 1 Test B
1
0.8
0.6
0.4
0.2
0
8:00 8:02 8:04 8:06 8:08 8:10 8:12 8:14 8:16 8:18 8:20 8:22 8:24 8:26 8:28 8:30 8:32 8:34 8:36 8:38 8:40 8:42 8:44 8:46 8:48 8:50 8:52 8:54 8:56 8:58 9:00


Contractor 2 Test B
1
0.8
0.6
0.4
0.2
0
8:00 8:05 8:10 8:15 8:20 8:25 8:30 8:35 8:40 8:45 8:50 8:55 9:00

Application - Outcome

- This study demonstrated a sophisticated Test and Evaluation system for stimulating sensors and simulating equipment performance
  - ISMS performance quantified across 152 scenarios
  - Able to differentiate between two systems
  - Effective detection limits for the *network* determined
  - Performance quantified as a function of the number of sensors
    - around 10 sensors optimal to protect 5x5km area
  - Results informed Main Gate decision (June 05)
  - System is flexible and available to other studies

We need to be able to answer questions such as these:

1. Should the military procure the networked bio-detection system A, B or neither?
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3. Is operational effectiveness achieved with better detection systems or better medical countermeasures?
4. How should the military react to a specific real time CB event?

Programme Aims

- The Impact Assessment Tool will link STAFFS and the VB to allow:
  - a user to predict the number and location of casualties in the event of a CB release
  - a user to predict how defensive equipment and procedures moderate casualties
  - a user to investigate how these factors affect mission objectives
- Linking the VB to STAFFS will allow both models to benefit from the strengths of the corresponding model

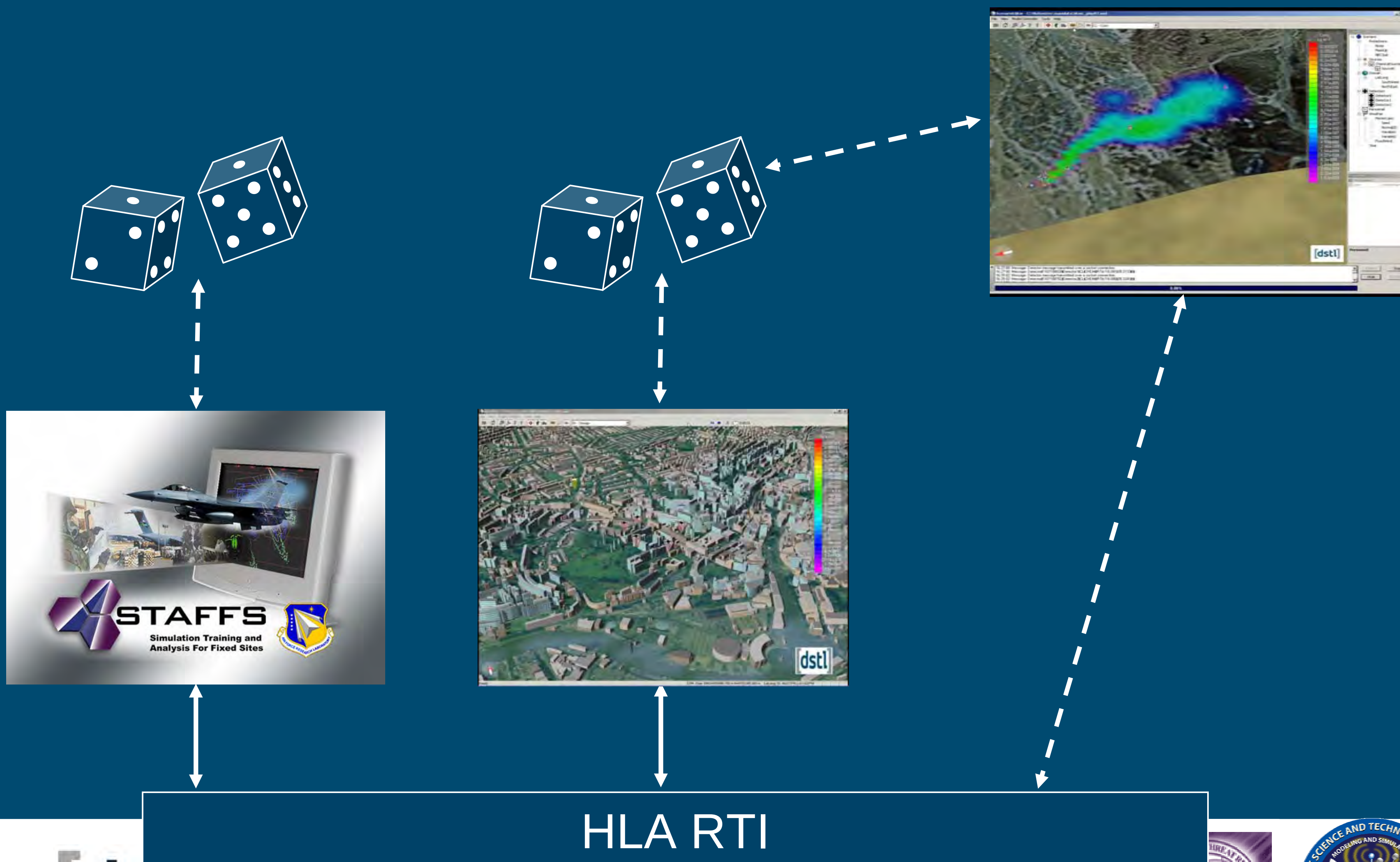
Benefits of System Linkage

- State of the Art Dispersion modelling
- Enhanced visualisation
- High resolution plume data taking into account high resolution fluctuations within the puffs
- Highly configurable CB modelling chain
- Interoperability with the latest CB capability through agreed interfaces
- Real-time entity simulation

Potential Linkage Methods

- Considered
  - File based
  - API based coupling
  - Web services
  - HLA
- Current plan is to use HLA

Proposed Method - HLA



Dstl is part of the Ministry of Defence

We need to be able to answer questions such as these:

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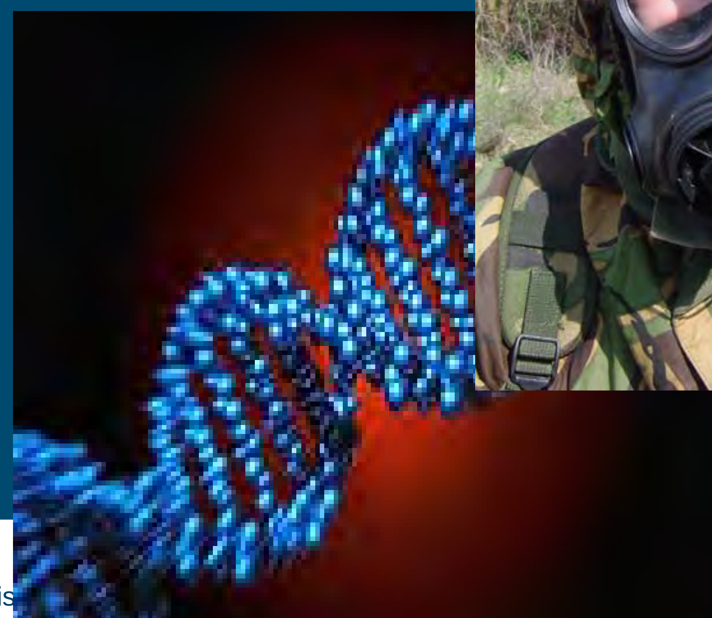
Future Challenges

Is operational effectiveness achieved with better detection systems or better medical countermeasures?

Balance of research requires

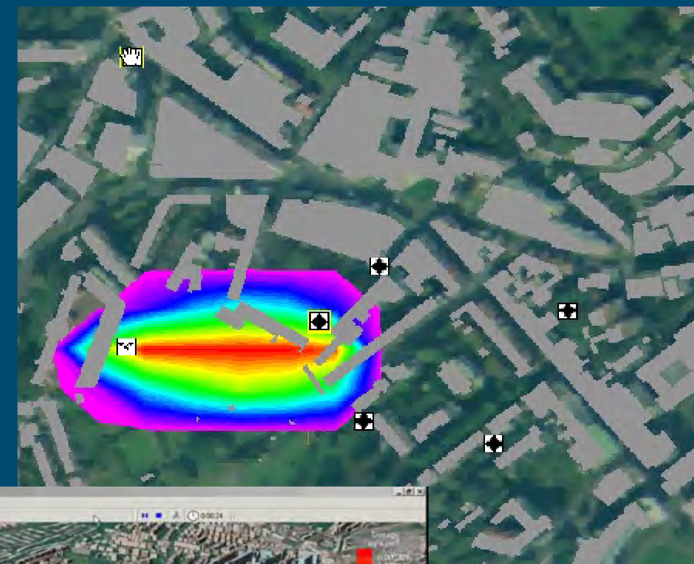
- simulation of entire CBRN defence system
- probabilistic modelling framework

- Work in progress...

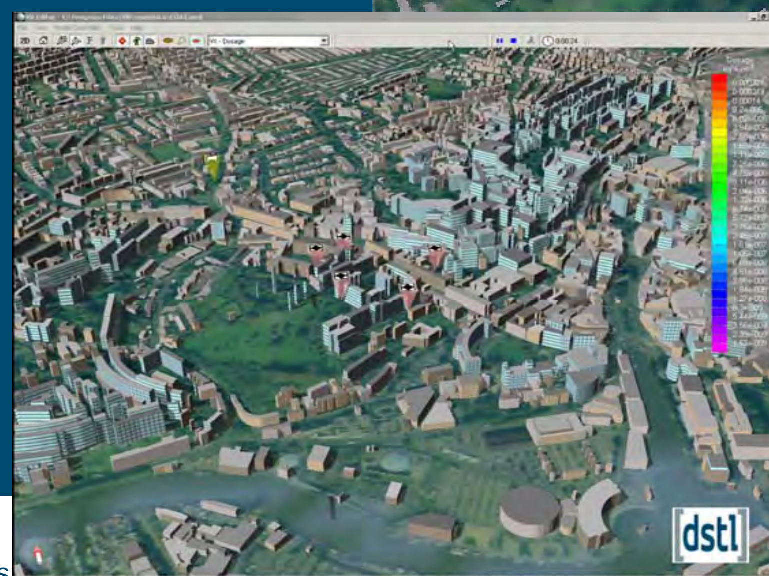


Future Challenges

How should the military react to a specific real time CB event?



- Support to real time operational decision making requires
  - very fast operational version of Virtual Battlespace
  - optimisation algorithms
  - probabilistic modelling framework



- Work in progress...

Summary

- CBRN OR can provide benefit across the full spectrum of the domain
- Have and improving capability to conduct OR
  – The Impact Assessment Tool contributes to this capability
- Clear benefits from linking systems
  – Reduced effort, cost and time to develop capability
  – Increased flexibility and functionality of capability
- Much work still to be done

JSTO Chemical and Biological Defense Physics-Based Modeling Program

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

Dr. Robert E. Marshall

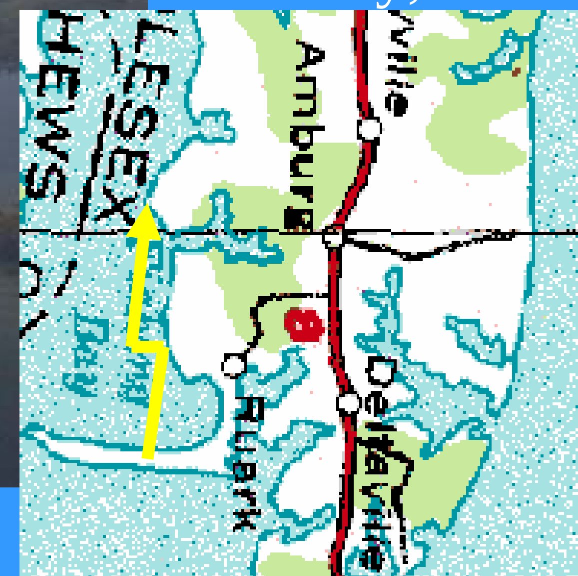
robert.e.marshall@navy.mil

T41 NSWCDD

JSTO Chemical and Biological Defense Physics-Based Modeling Program

Mouth of the Piankatank River Chesapeake Bay

Ground level Biomass Burn January, 2001



What validated technologies exist?

What technologies must be developed and/or validated?

Coastal and Littoral

Objectives

- Focus on the land/sea interface
- Atmospheric releases
- Accurate modeling capability to predict hazard
- Model development → empirical → coupled NWP
- Model Validation → data → field program

Coastal and Littoral

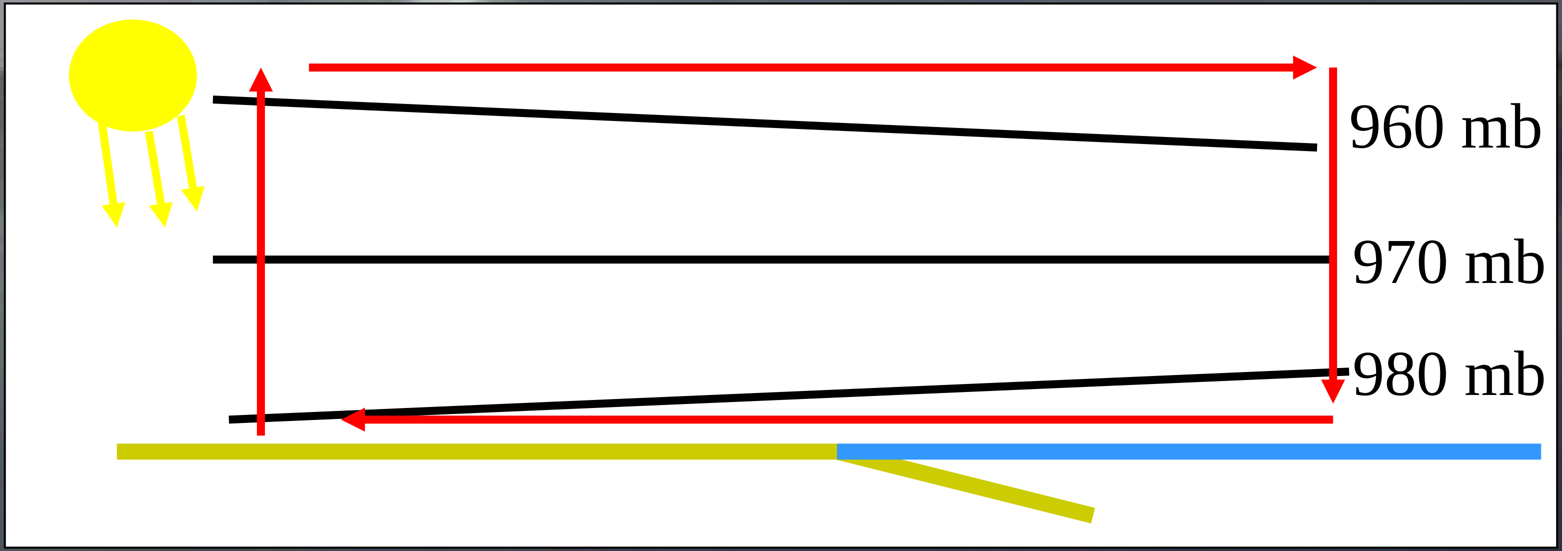
Coastal Circulations

- True child of the sun
- Thermal circulation in the presence of contrast between the heat capacity and thermal conductivity of the land and adjacent water
- Basic unit is the sea breeze

Coastal and Littoral

Sea Breeze

- Sun heats the land
- Land heats the surface air by conduction
- Convective turbulence heats the upper air



Coastal and Littoral

Sea Breeze Circulation

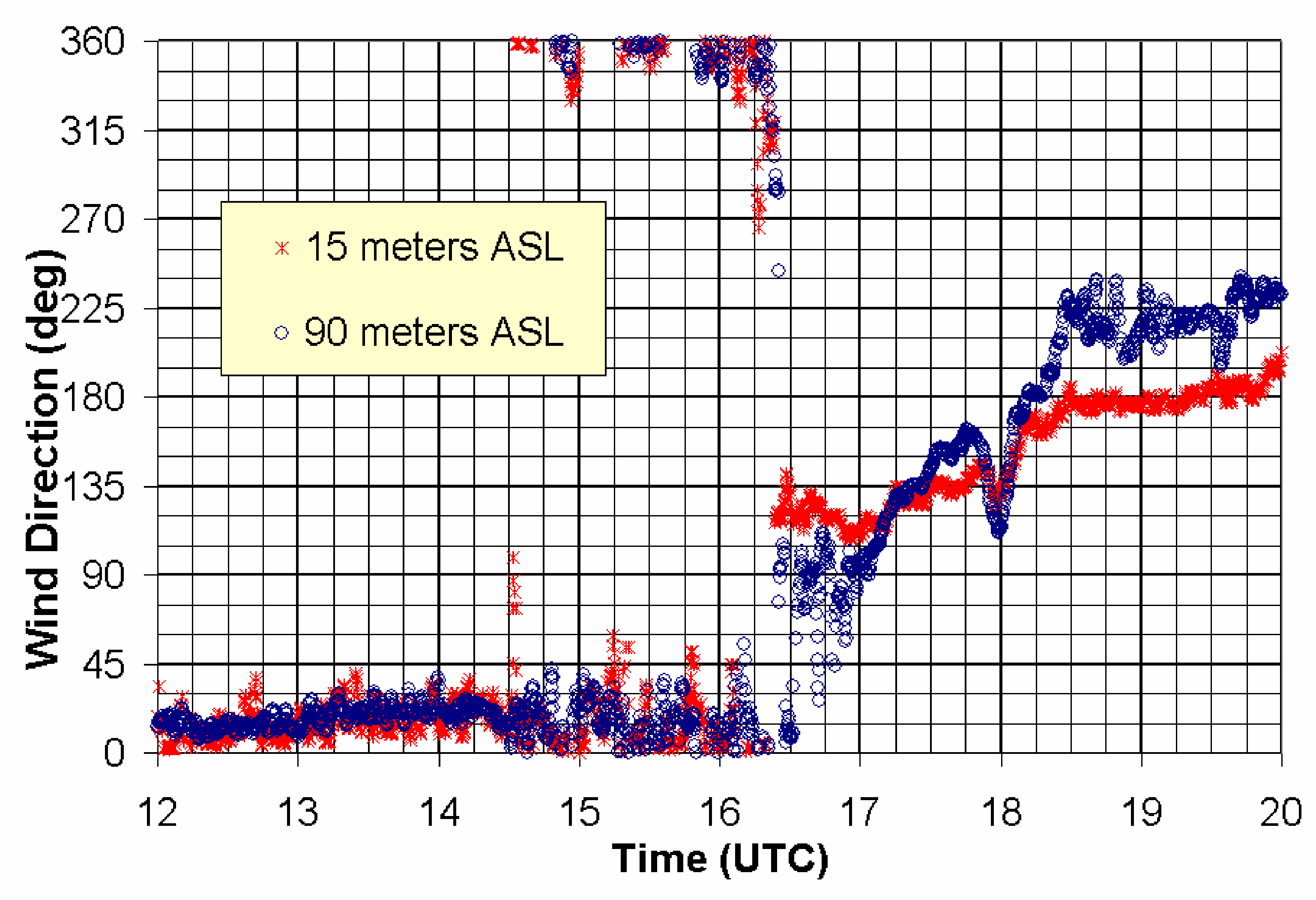
- 25 km inshore
- 50 km offshore
- 500-1000m deep
- 10-20 kt winds surface up to 100m

Coastal and Littoral

Sea Breeze Circulation

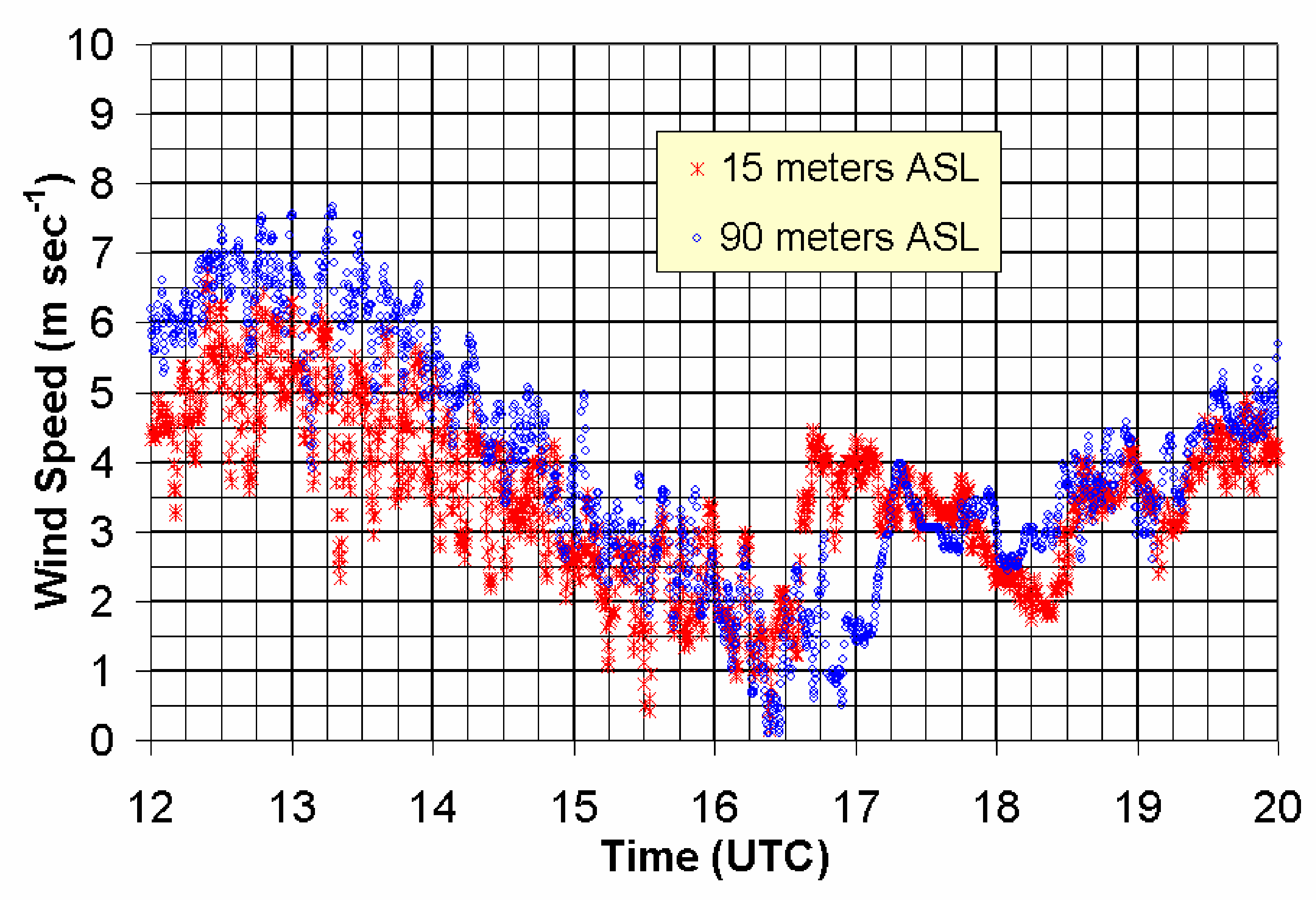
- Sea breeze front begins to move towards shore when ΔT is 3-6deg C
- Convection can appear along sea breeze front
- Sea breeze dies out 1-2 hours after sunset
- Weaker land breeze may form as land cools below temperature of water

Coastal and Littoral



Wallops Island, VA 29 April 2000

Coastal and Littoral



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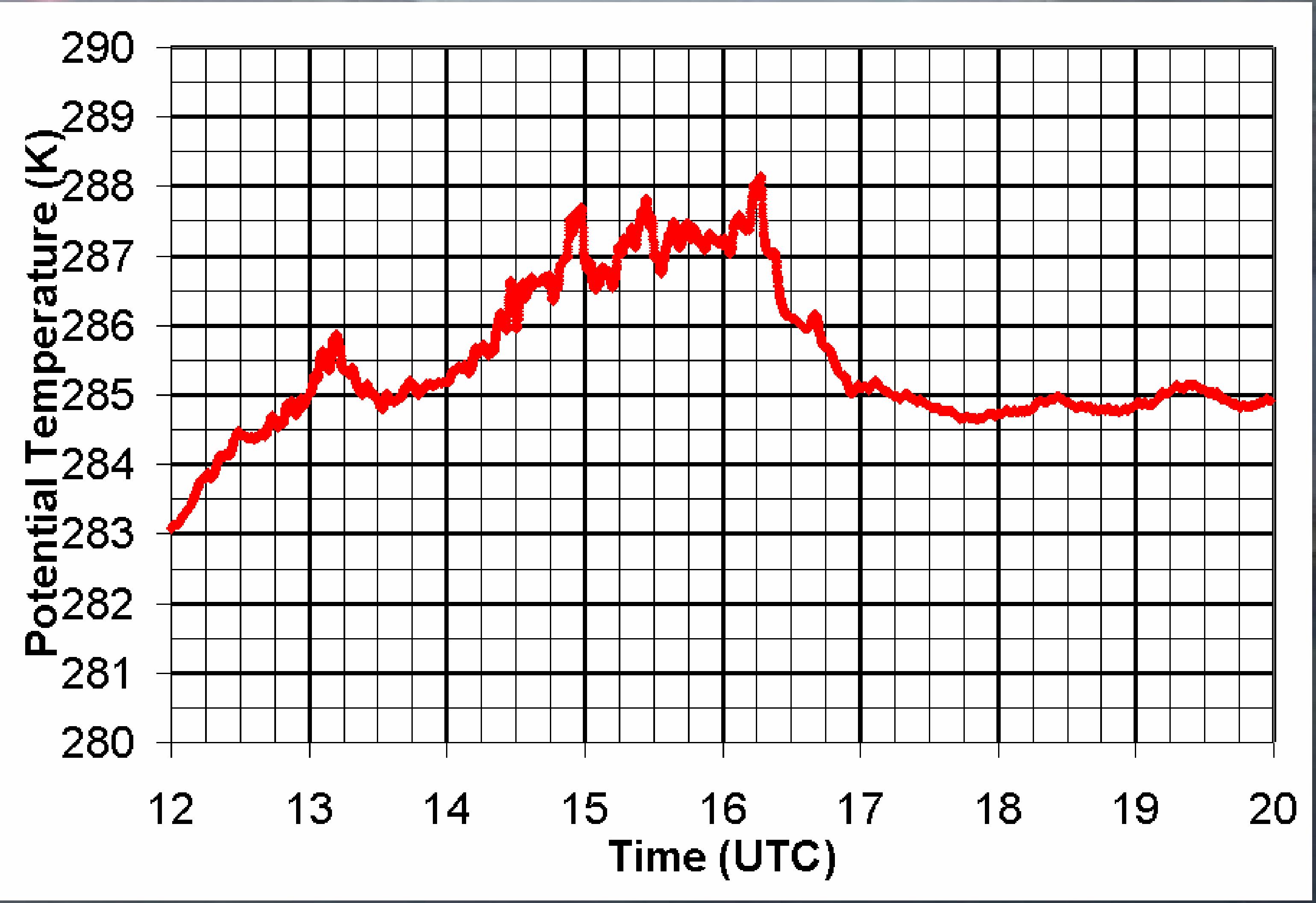

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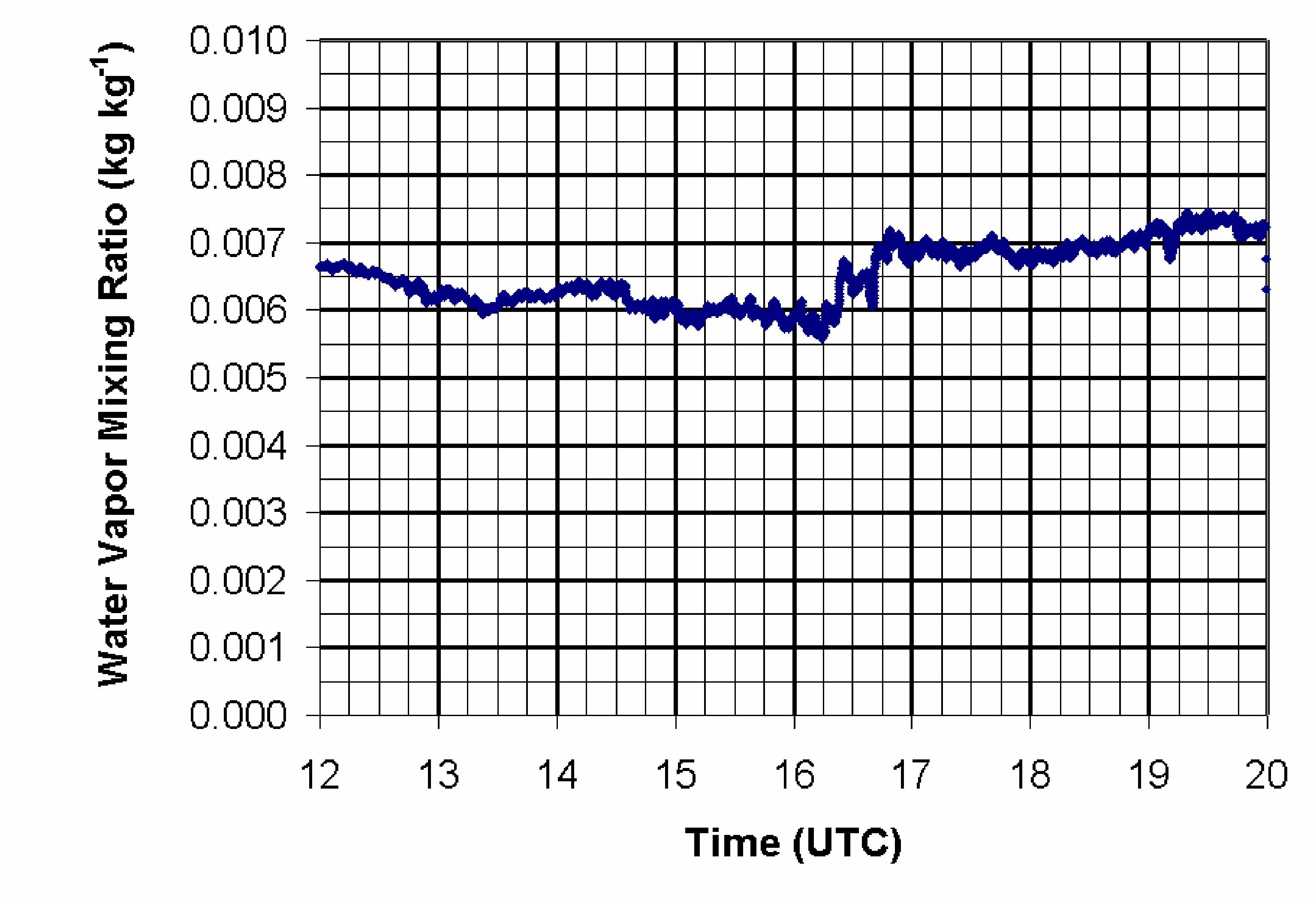


Wallops Island, VA 29 April 2000

Coastal and Littoral

Modifications to Sea Breeze

- Coastline shape: convergence/divergence
- Coastal terrain: mountain or valley winds may enhance or inhibit sea breeze circulations
- Low level inversions over land: limit vertical extent of heating and weaken sea breeze
- Coriolis induces late afternoon veering

Coastal and Littoral

Similar Circulations

- Lake breeze: Great Lakes, Lake Okeechobee
- River breeze: Landing at National Airport
- Desert breeze: differential heating-contrasting albedo of types of sand- Dugway Proving Ground

Coastal and Littoral Components

- Literature search for data/models/theory
- Empirical model development
- Leverage meteorological data
  - **improvements in mesoscale NWP**
  - **remote and in situ sensor data assimilation**
  - **coupled ocean/atmospheric modeling**
- Field testing
- Improved coupled met and T&D model

Coastal and Littoral

Literature Search for Data/Models/Theory

- **Investigation of Data and Remote Sensing Needed for Supporting Transport and Dispersion Forecasts for Chem/Bio Threat Mitigation In Coastal and Littoral Regions**
  NOAA/ATDD

- **Measurement of Coastal & Littoral Toxic Material Tracer Dispersion**
  NSWCDD

Coastal and Littoral

Empirical Model Development

- Land Sea Temperature Difference
- Offshore wind speed
- Coastline shape
- Surface heat flux
- Dstl, Porton Down

Coastal and Littoral

Leverage Meteorological Data

- Investigation of Data and Remote Sensing Needed for Supporting Transport and Dispersion Forecasts for Chem/Bio Threat Mitigation In Coastal and Littoral Regions
  - NOAA/ATDD
- Coupled Air-Sea Modeling for Improved Coastal Dispersion Prediction
  - NRL-MRY
- Measurement of Coastal & Littoral Toxic Material Tracer Dispersion
  - Weatherflow
  - NRL-MRY

Coastal and Littoral

Field Testing

- Measurement of Coastal & Littoral Toxic Material Tracer Dispersion
  - NSWCDD
  - Weatherflow
  - NRL-MRY
  - NPS
  - JHU/APL
  - NASA/WFF
- October 2004 Sea Breeze Workshop

Coastal and Littoral

Improved Coupled Met and T&D Model

- DTRA/TDOC/HPAC
  - Meteorological Research Team
    - PSU
    - NOAA
    - NCAR/RAL
- DTRO-L
  - Workshop on Uncertainty in Transport and Dispersion of CBRN Materials

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

Two week met and T&D sea breeze measurement program

- **NSWCDD**
  Program management, met measurements, chaff release, experiment control center
- **NRL-MRY**
  High resolution COAMPS modeling and data assimilation
- **Weatherflow**
  Meteorological measurements, high resolution RAMS modeling and data assimilation
- **JHU/APL**
  Meteorological measurements
- **Naval Postgraduate School**
  Meteorological measurements
- **NASA/WFF**
  SPANDAR

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

NSWCDD

- Program Management
- Boat based chaff release
- Boat based surface and GPS upper air met, SST-5 to 65km offshore
- Shoreline surface met measurements
- Land mobile GPS radiosonde system
- Experiment control center-real time telemetered met data

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

NRL-MRY

- Literature Search
- Wallops Island Sea Breeze Climatological Study
- 3km horizontal resolution COAMPS modeling
- Data assimilation
- Forecast team member

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

Weatherflow

- Literature Search
- Wallops Island Sea Breeze Climatological Study
- 2km horizontal resolution RAMS modeling
- Along coast surface met sites
- Data assimilation
- Forecast team member

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

JHU/APL

- Literature Search
- Helicopter MABL soundings 5 to 65 km offshore
- Rocketsonde soundings 0-5 km offshore
- Surface met measurements and SST 0-5km offshore

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

Naval Postgraduate School

- Literature Search
- Offshore Reynolds fluxes
- Offshore wave heights

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

NASA Wallops Flight Facility

- SPANDAR
- 00UTC and 12UTC synoptic soundings
- 3 surface met sites
- Shoreline wind tower (15,30,45,60,75,90m ASL)
- WFF climatological sea breeze study

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

CHAFF ???

- Flow dimensions on the order of 100km
- Chaff concentration proportional to measured radar reflectivity (no chemistry or biology)
- 25 micron diameter aluminum coated mylar cut to $\lambda/2$ (5cm)
- 1 cm sec^{-1} terminal velocity
- variance of Doppler spectrum related to turbulence intensity

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

SPANDAR

- Space Range Radar
- Range resolution = 75 meters
- Azimuth resolutiom = 340 meters at 50km
- 1 chaff filament per range bin at 50km provides a > 10dB signal to noise
- Data analysis and display tools well exercised at NSWCDD

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

FY06

- Develop WFF sea breeze climatology
- Fabricate, mount and test chaff release system
- Maintain and calibrate land and sea based meteorological hardware
- WFF environmental assessment
- Test site preparations
- Engage empirical model developers
- NWP model development
- Develop a test plan

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

FY07

- Obtain expendables
- Establish forecast team
- Install auxiliary surface meteorological sites
- Move hardware to WFF
- Install control center
- Two week field program
- Remove hardware from WFF
- Archive data
- Experiment first look

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

FY08

- Data Analysis
- NWP model testing
- Empirical model testing
- Workshop

Coastal and Littoral

Measurement of Coastal & Littoral Toxic Material Tracer Dispersion

Experiment Holes

- Land based Reynolds flux measurements
- Doppler Lidar technology (winds)
- Raman Lidar (temperature and humidity profiles)
  Some NAVSEA interest
- We invite participation

Coastal and Littoral

Coastal and Littoral

Coastal and Littoral

Coastal and Littoral

JOINT SCIENCE AND TECHNOLOGY OFFICE
CHEMICAL AND BIOLOGICAL DEFENSE

NAVSEA
WARFARE CENTERS
DAHLGREN

EXPANDING THE REALM OF POSSIBILITY

Predictive Models for Chem-Bio Human Response, Casualty Estimation and Patient Loads

Chem-Bio Information Systems 2005

Albuquerque, NM

Gene McClellan, Karen Cheng, and Jason Rodriguez

27 October 2005

JOINT SCIENCE AND TECHNOLOGY OFFICE
MODELING AND SIMULATION
BATTLESPACE MANAGEMENT
CHEMICAL AND BIOLOGICAL DEFENSE

APPLIED RESEARCH ASSOCIATES, INC.
An Employee-Owned Company

Topic Outline

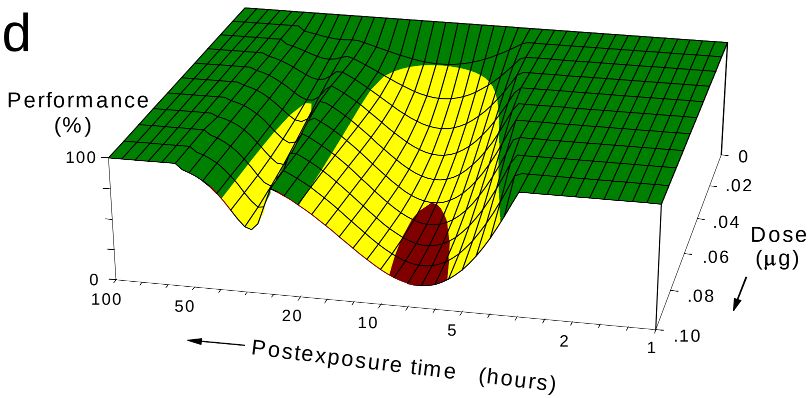
- Human response / human performance – historical foundation
- Casualty estimation
- Patient loads
- Applications
  - NBC Casualty and Resource Estimation Support Tool (NBC CREST)
  - Consequence Assessment Tool Set (CATS)
  - Joint Operational Effects Federation (JOEF)

DTRA Developed the Methodology for NBC Effects on Human Performance

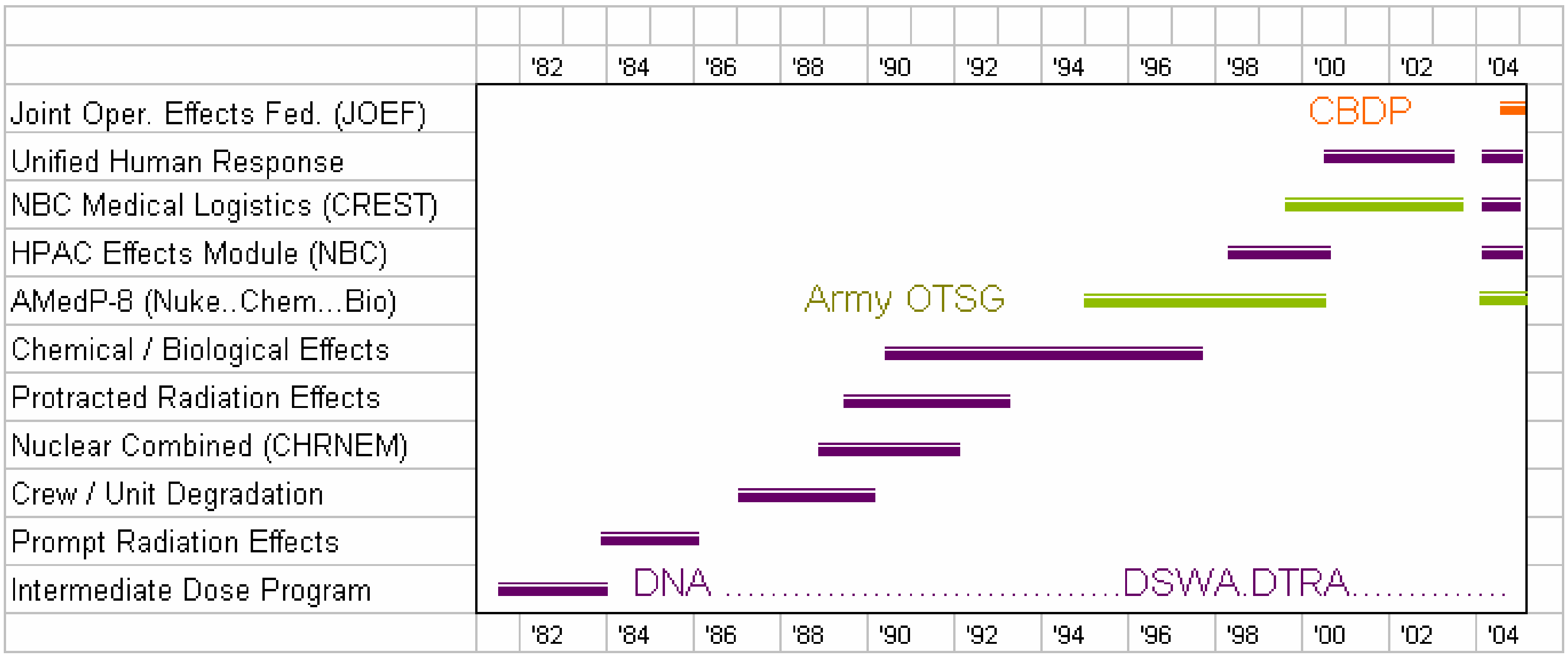
- Intermediate Dose Program, **1981...**
  - Battlefield impact of acute radiation sickness
  - *illness* $\rightarrow$ *symptoms* $\rightarrow$ *performance*
  - Performance degradation = task time extension
- Human Response Program, **late ‘80s**
  - Individual $\rightarrow$ Crew/Unit Degradation
  - Nuclear combined injury, psychological effects …
  - Combined Human Response Nuclear Effects Model (CHRNEM)
  - Protracted radiation doses

Developments Continued into the '90s

- Radiation Risk/Safety Program
  - Radiation-Induced Performance Decrement (RIPD) software
  - Extend methodology to chemical agents and kinetic injury
  - Performance impact of individual protective gear
- NBC Consequence Assessment Program
  - biological agents
  - CENTCOM interest in port and airfield operations after NBC attack
- Human effects modules including casualty estimation for the Hazard Prediction and Assessment Capability (HPAC)



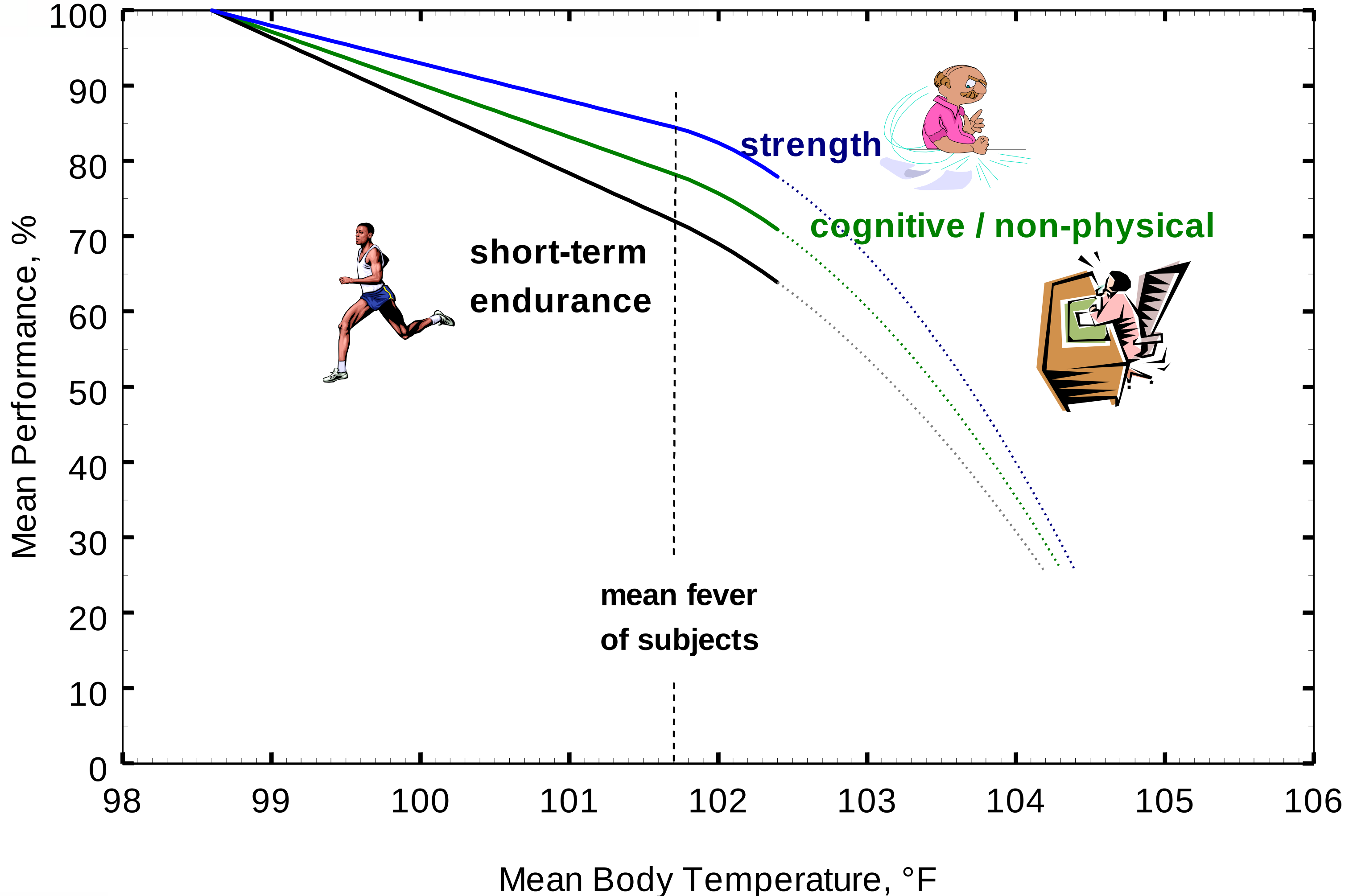
DTRA Foundation for CBRN Health Effects is Widely Applied



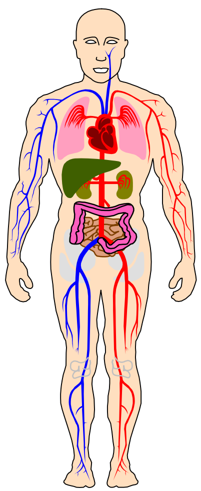
Human Response: Object-Oriented Design for the CBRN Effects Module

- BaseModel
  - BioModel
    - AnthraxModel
    - BotulismModel
    - BrucellosisModel
    - GlandersModel
    - PlagueModel
    - QfeverModel
    - SEBModel
    - SmallpoxModel
    - TularemiaModel
    - VEEModel
  - ChemModel
    - GBModel
    - VXModel
    - HDModel
  - NuclearModel

Performance Impact of Short-Term Febrile Illness Based on Clinical Data



Casualty Estimation is Based on NATO AMedP-8 Methodology

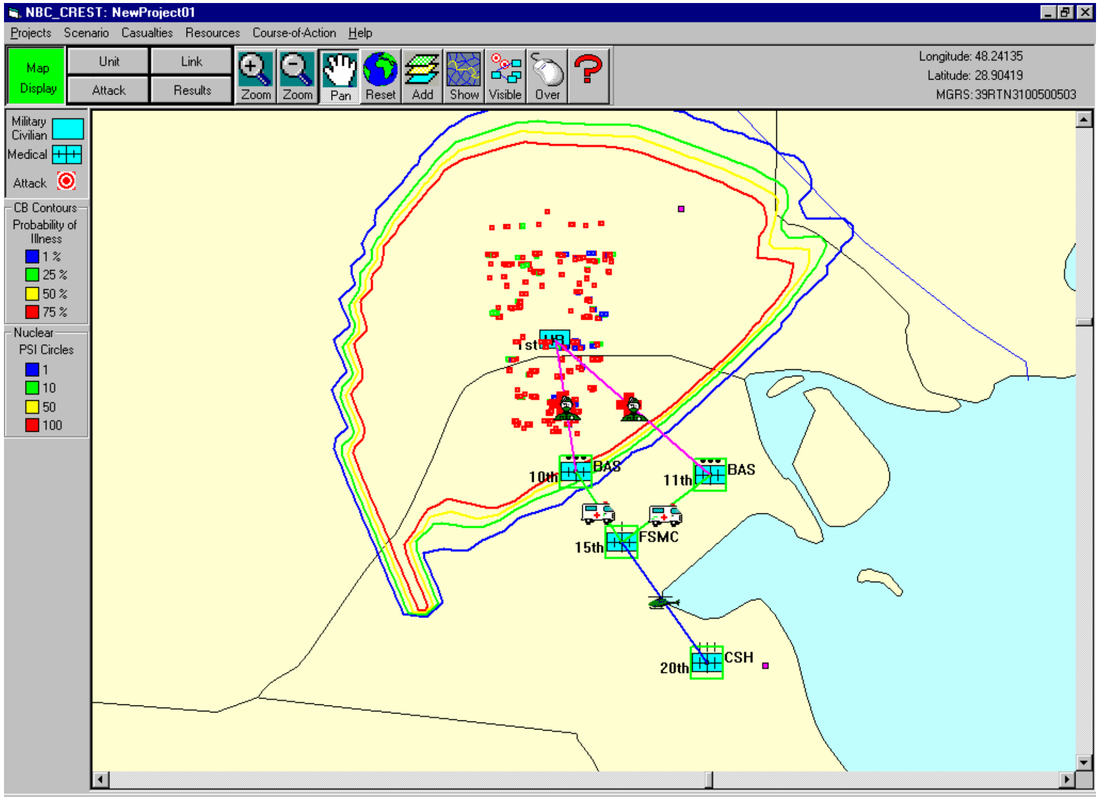


- Sign/symptom (S/S) severity profiles based on time- & dose-dependent descriptions of human response
- S/S severity profiles are used to determine performance degradation
- Performance (P) degradation calculations are used to estimate casualties (i.e. operational casualties, P $\leq$ 0.25)
- US (OTSG) is the NATO custodian
- N, B, and C volumes ratified by NATO in Feb 01

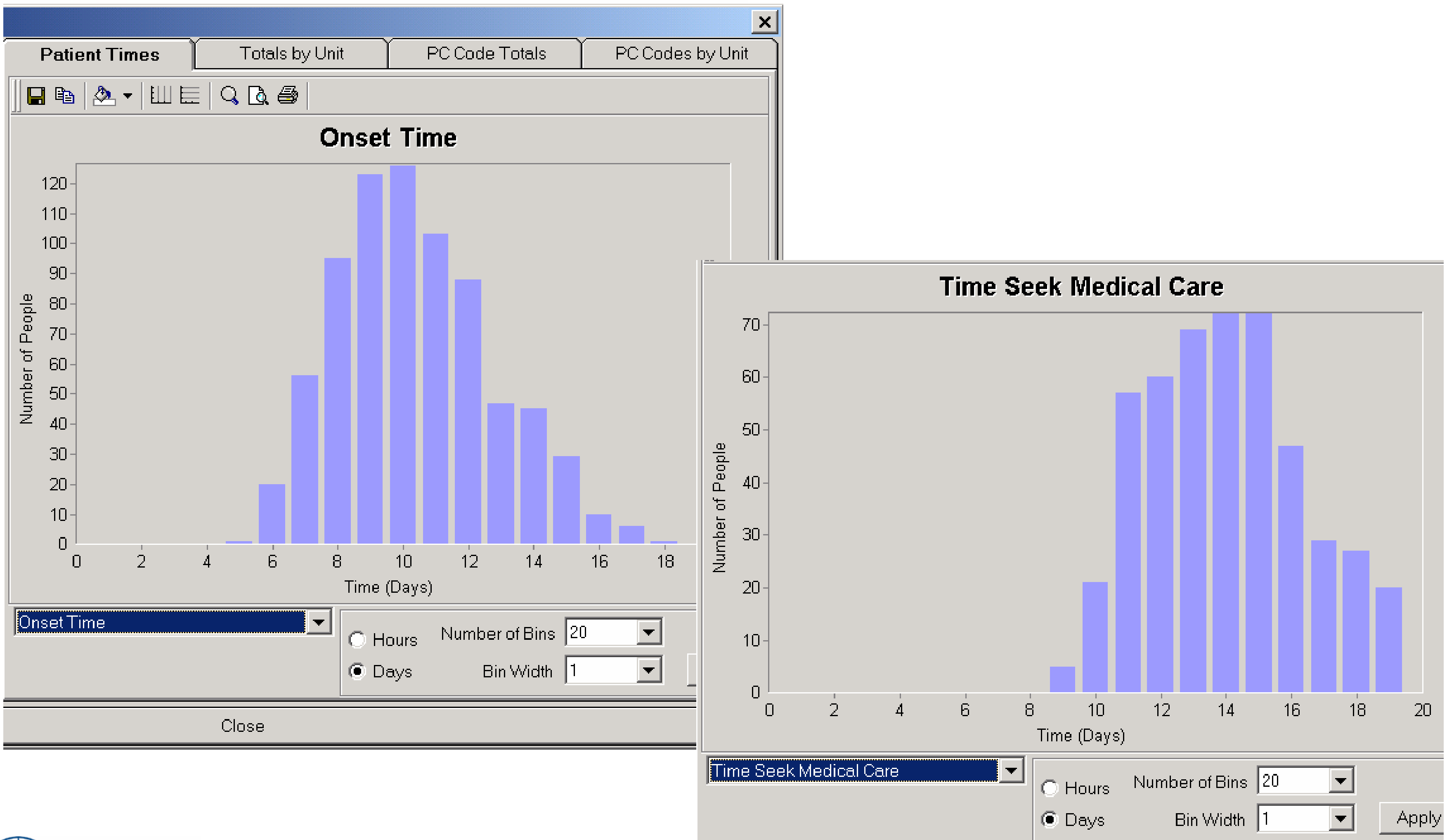
Allied Medical Publication 8 (AMedP-8): *Medical Planning Guide for the Estimation of NBC Battle Casualties, Three Volumes, N, B and C.*

NBC CREST Casualty Estimation Module Uses AMedP-8 Methodology in User-defined Scenarios

- Planner defines the NBC casualty/attack scenario in accordance with current threat assessment and operational requirements
- Positions units or population on a map
- Adds network of Medical Treatment Facilities (MTFs)
- Chooses attacks
- Calculates casualties
- Saves patient stream



Patient Loads: Smallpox Model Illustrates Time-phasing of Illness



The Defense Medical Standardization Board (DMSB) Defines *Patient Condition* (PC) Codes

Example: PCs for Nerve Agent Exposure

Code	***Patient Condition***
382	**Nerve Agent Vapor Only (Inhalation) Mild**
383	**Nerve Agent Vapor Moderate**
384	**Nerve Agent Vapor Severe**
385	**Nerve Agent Liquid Mild**
386	**Nerve Agent Liquid Moderate**
387	**Nerve Agent Liquid Moderately Severe**
388	**Nerve Agent Liquid Severe**

DMSB Treatment Brief for VX Exposure

PC 385 -- Nerve Agent Liquid Mild

<u>ECHELON 1A</u>

<u>Assumptions</u>: 100% ambulatory. Focal areas of sweating and muscle fasciculations in areas exposed to liquid agent, but no skin irritation. No significant systemic symptoms and no miosis, hyperemia, eye pain, or headache are present. Personal decontamination should be performed in exposed areas. Local symptoms are likely to progress and systemic symptoms will develop if skin was not adequately decontaminated promptly (within 2-3 minutes), and progression of symptoms may continue for up to 18 hours.

<u>Treatment</u>: One Mark I kit immediately from patient's supply. Check decontamination of exposed areas if not already done. Evacuate 100% to echelon 1B.

<u>ECHELON 1B</u>

<u>Assumptions</u>: 100% ambulatory. 100% decontaminated prior to medical treatment. Focal areas of sweating and muscle fasciculations in areas exposed to liquid agent, but will not have skin irritation. No significant systemic symptoms and no miosis, hyperemia, eye pain, or headache are present. Signs and symptoms are likely to progress if skin was not adequately decontaminated promptly (within 2-3 minutes), and progression may continue for up to 18 hours.

<u>Treatment</u>: VS, pulmonary examination. One to two Mark I kits from patient's supply as clinically indicated if systemic effects of nerve agent recur. 100% evacuate to echelon 2.

<u>ECHELON 2</u>

<u>Assumptions</u>: 100% ambulatory and decontaminated. Focal areas of sweating and muscle fasciculations in areas exposed to liquid agent, but will not have skin irritation. No significant systemic symptoms and no miosis, hyperemia, eye pain, or headache are present. Mild systemic manifestations (nausea, vomiting, and stomach cramps) have begun because of effects of absorbed agent.

<u>Treatment</u>: VS, pulmonary examination. Start IV(1%). Observation for up to 24 hours with further Mark I (use patient's supply first) or atropine treatment IM (30%) or IV (1%). RTD 100%.

Patient Conditions for VX are Affected by Both Vapor and Liquid Exposure

(Dosage levels in mg-min/m^3, deposition in mg/m^2.)

<u>GB (use vapor dosage levels)</u>

$0.25 \leq$ dosage < 6 then PC 382
$6 \leq$ dosage < 30 then PC 383
$30 \leq$ dosage then PC 384

<u>VX (decide if greater proportion of effective dose is vapor dosage or liquid deposition)</u>

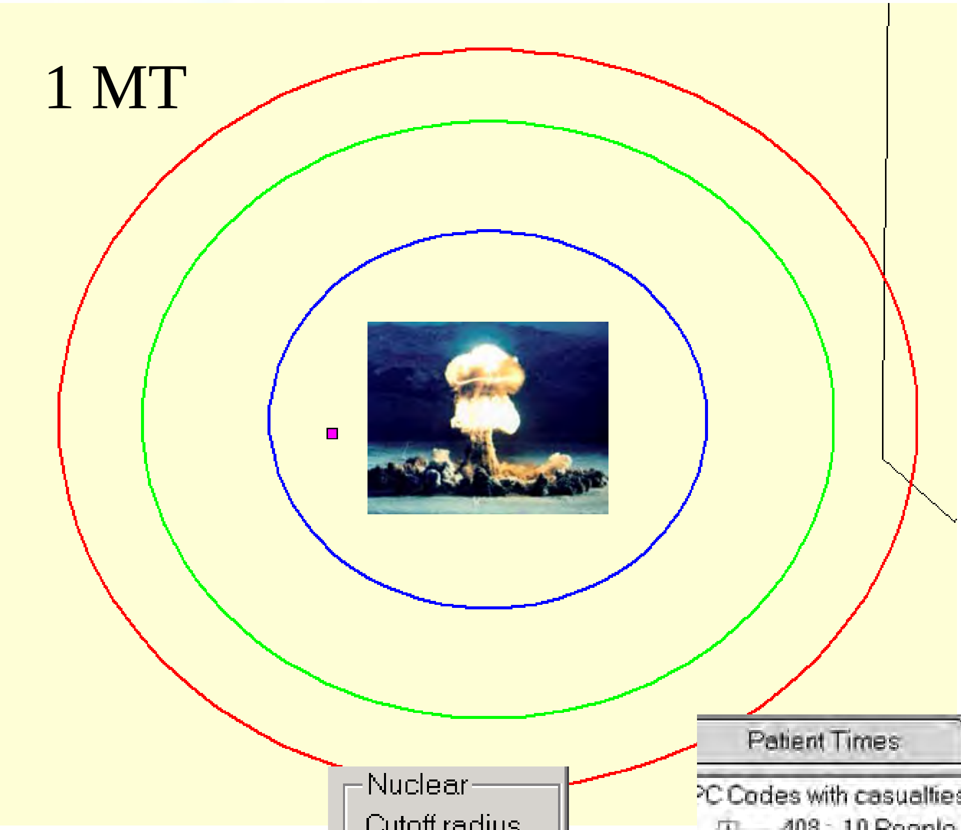
If >50 % vapor:

dosage < 0.05 then no PC
$0.05 \leq$ dosage < 4 then PC 382
$4 \leq$ dosage < 19 then PC 383
$19 \leq$ dosage then PC 384

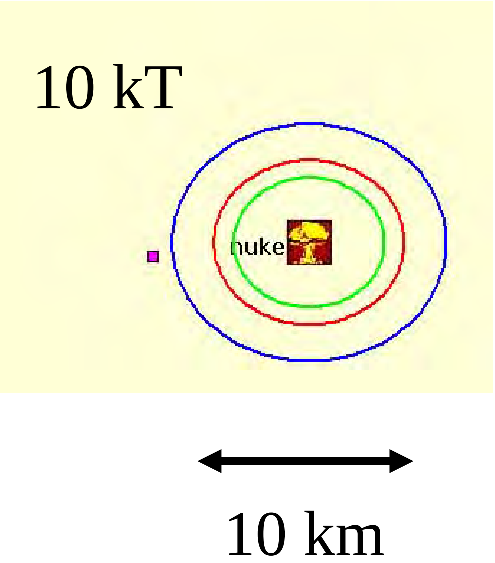
If > 50% liquid

$0.01 \leq$ dose < 0.8 then PC 385
$0.8 \leq$ dose < 2.0 then PC 386
$2 \leq$ dose < 4.0 then PC 387
$4.0 \leq$ dose then PC 388

Consistent Approach Used for Patient Definition Across CBRN Health Effects



Nuclear
Cutoff radius for indicated effects.
.05 Rads
1 PSI
1 cal/cm^2



__Note spectrum of patients (PCs)__

Patient Times | Totals by Unit | **PC Code Totals** | PC Codes by Unit

PC Codes with casualties
- 408 : 10 People : Radiation: level R7(>15 Gy)
- 412 : 30 People : Radiation R5/R6/R7 (>5 Gy) with operative trauma
- 415 : 100 People : Radiation R5/R6/R7 (>5 Gy) with non-operative trauma
- 414 : 30 People : Radiation R3/R4 (1.25-5 Gy) with non-operative trauma
- 403 : 40 People : Radiation: level R2(0.75-1.25 Gy)
- 402 : 3590 People : Radiation: level R1(0.5-0.75 Gy)
- 404 : 70 People : Radiation: level R3(1.25-3.0 Gy)
- 434 : 30 People : Radiation R3/R4/R5/R6/R7 (>1.25 Gy) with operative trauma and moderate c

10 kT

Foregoing Methods Are Implemented in the Medical NBC Casualty and Resource Estimation Support Tool (NBC CREST)

- Originating Agency:
  U.S. Army
  Office of The Surgeon General
  Health Care Operations
  NBC Defense Staff Officer
- Transition Partner:
  DTRA
  Technology Development
  Directorate

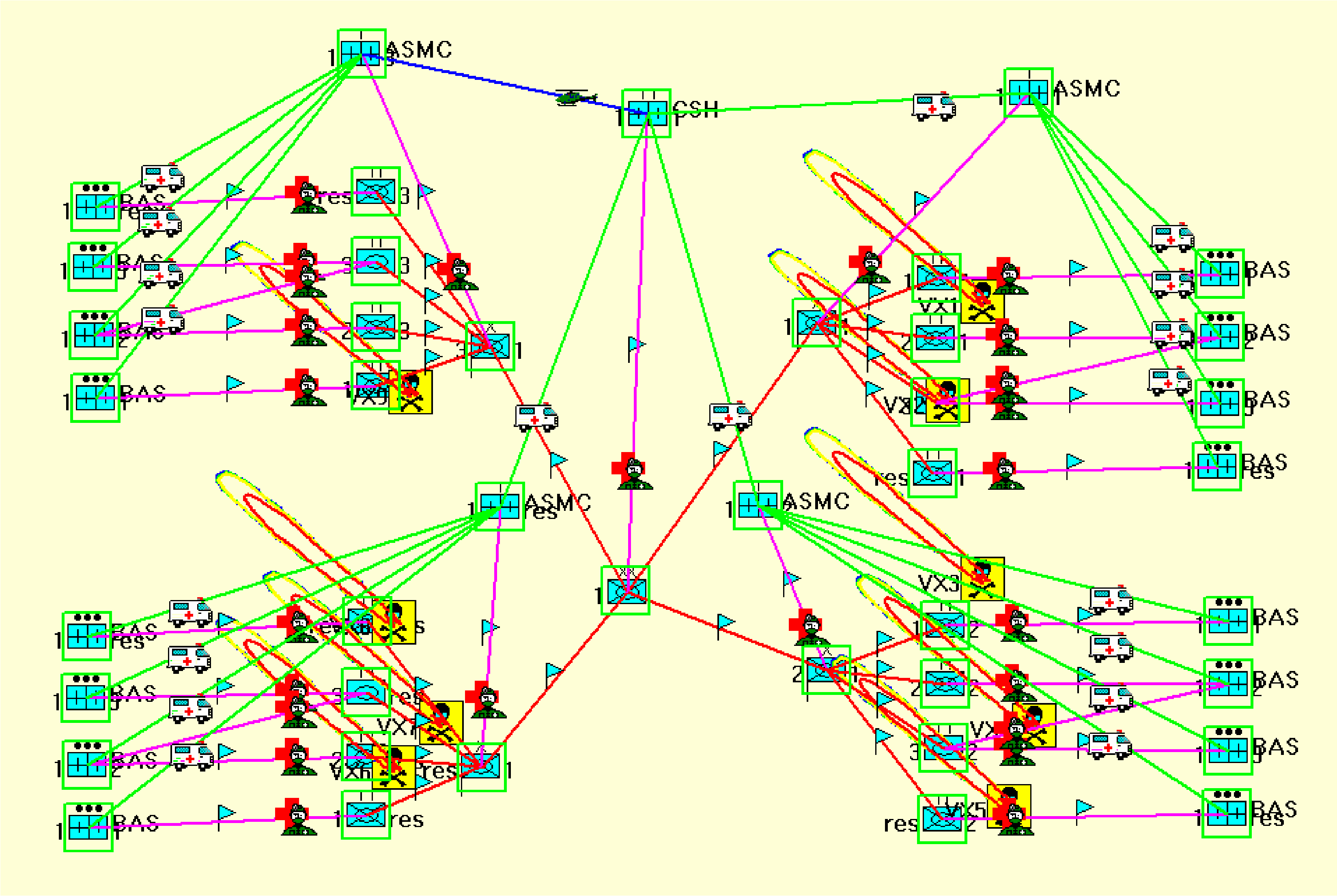
Medical NBC CREST

- **Purpose**
  - Enable advanced planning for medical operations in an NBC environment
- **Objective**
  - Provide Medical Planners with a Tool Set to:
    - Estimate NBC casualties
    - Estimate medical requirements
    - Analyze alternate medical Courses of Action (COAs) (i.e., Gap Analysis)

NBC CREST Capabilities

- Map-based ***scenario*** definition
  - Both troop deployments and civilian population
  - Both command structure and evacuation networks
- Estimation of ***casualties*** with AMedP-8 methodology
  - Provides original AMedP-8 scenarios (VLSTRACK)
  - Will import new plumes from HPAC
  - Nuclear weapons, biological agents, chemical agents
- Provides ***patient stream*** by time of occurrence and by DMSB patient condition
- Joint medical treatment facilities (MTFs) at Levels 1, 2, 3, 4 and 5
- Medical resource requirements by day and level of care
- MTF shortfalls by day and level of care
- Models vaccination, prophylaxis, secondary infection

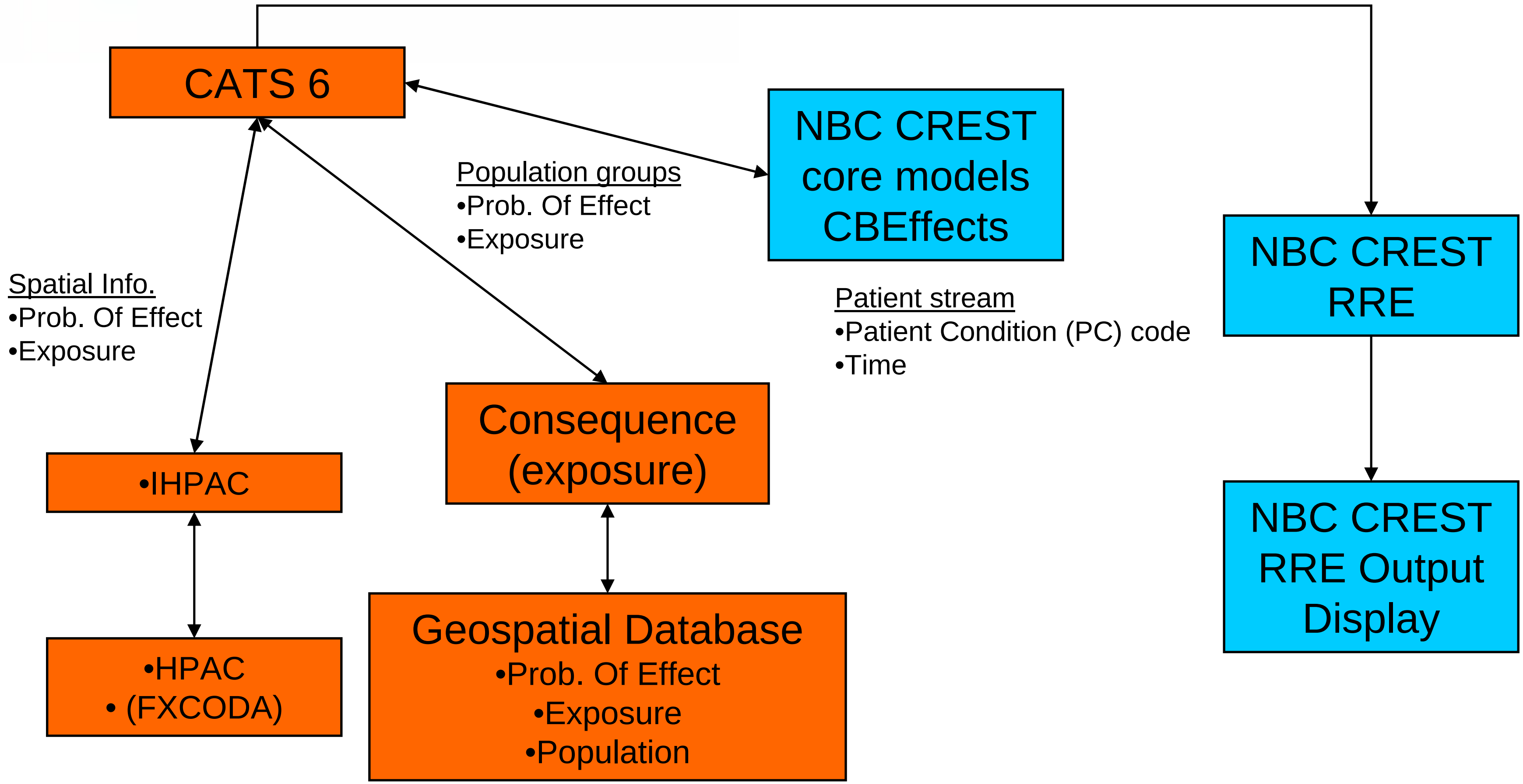
The NBC CREST GUI Supports Large Deployments



NBC CREST in Transition

- OTSG maintains purview over the underlying medical planning technology
- Care and feeding of the software application and components transitioned to DTRA
- Deliberate planning capabilities provided by NBC CREST will be integrated with DTRA's Consequence Assessment tools such as CATS
- Simulation capabilities provided by NBC CREST are being integrated with the Joint Operational Effects Federation (JOEF)
  - Medical effects on individual performance capability
  - Delivery of medical care

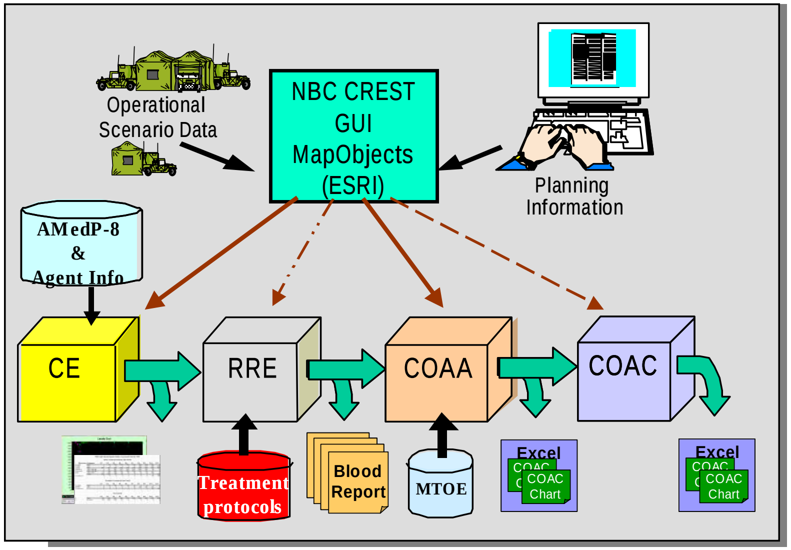
Initial NBC CREST Integration With DTRA's Consequence Assessment Tool Set (CATS)



Integration of NBC CREST with JOEF

- Accept hazard / exposure data and troop locations from Federation
- Return performance capability / casualties
- Return medical resource requirements
- Match requirements against medical infrastructure

- Adapt modules from NBC CREST to JOEF



Conclusion: High-level Goals

- Maintain compatibility of health effects predictive models across DoD programs, e.g.
  - JEM
  - JOEF
  - HPAC
  - CATS
  - Integrated WMD Toolset (IWMDT)
  - Medical Analysis Tool (MAT)
  - Tactical Medical Logistics (TML+) planning tool
- Maintain currency with applicable COTS technology
- Support efforts to place CBRN casualty estimation in context with conventional casualty estimation

EMPLOYING VIRTUAL REALITY SIMULATION TO TRAIN FOR PREVENTION, DETERRENCE, RESPONSE, AND RECOVERY FOR CHEM BIO EVENTS

Presented by:

Scott Milburn, Reality Response

SVS is a state-of-the-art, turn-key, high-fidelity, Individual Combatant (IC) virtual simulation system. Featuring real-time 3D graphics, directional audio portals and a unique user interface into the virtual battlefield, SVS enables you to realistically insert a human-in-the-loop IC into a networked simulation.

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threat response technology

AMTI

SVS Military Background

SVS has been the Army's primary virtual reality simulation training system used for individual and team dismounted infantry training for nearly 10 years.

SVS is the only fielded solution in use at the Soldier Battle Lab (SBL). SBL is the United States Army's lead agency for IC simulation and is located at Ft. Benning, Georgia, home of USA infantry.

SVS has been selected by PEO STRI as the core simulation system for dismounted infantry training for the improved Close Combat Tactical Trainer (CCTT) Dismounted Infantry Manned Module (DIMM), which is expected to become the core of the Soldier Combined Arms Tactical Trainer (Soldier CATT).

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[redacted]

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SVS Military Firsts

- Feb. 94: First dismounted infantry virtual simulation
- Oct. 94: First 3D audio COTS simulation solution
- Feb. 97: First HLA commercial product
- Feb. 97: First sim to port an HLA RTI to Linux
- Aug. 97: First COTS and PC-based dismounted infantry system
- Dec. 97: First HLA certified compliant simulator
- Nov. 98: First Weapons Inspection / Treaty virtual simulation
- July 99: First virtual chemical/biological simulation
- Nov. 01: First Land Warrior embedded simulation system
- May 02: First wearable interface for dismounted infantry
- Sept. 04: First demonstration of VR sim with operational troops

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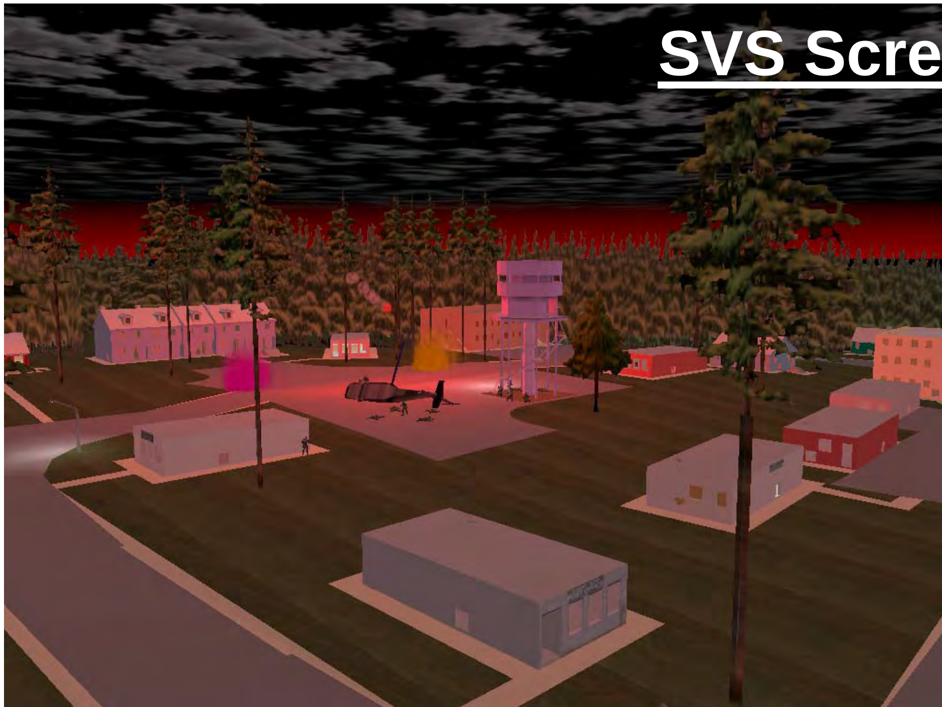
SVS-DI

First fielded in August 1997

- Human-in-the-loop Virtual Simulator
- Stand-up and Desktop Configurations
- Cost Effective PC-based
- DIS and HLA compatible
- SEDRIS Terrain Support
- Reconfigurable for DI, Treaty Inspection and Chem/Bio Training
- Fully Supported COTS Product
- Land Warrior support


SVS-DI
Features:
-Flares
-Tracers
-Tactical Smoke
-Flash Bang Grenades
-Multiple Weapons (7)
-Accurate Ballistics (EST)
-Flashlights
-Street and Internal Building Lights
-Dynamic Terrain
Useful for:
- ACR
- SMART
- TTP development
- Training
- Mission Rehearsal

SVS Screen Shots



VERTS Program

In 2000, Reality Response developed the Virtual Emergency Response Training System (VERTS) as a proof-of-concept for the National Guard Bureau. The purpose was to demonstrate the potential to use virtual reality simulation to train the National Guard Weapons of Mass Destruction Civil Support Teams (CSTs).

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VERTS Immersive Station

The VERTS program included the development of a stand-up immersive interface to the VR simulation system.

High fidelity, low cost PC

3D computer graphics and sound

- Human-in-the-loop moving and interacting in virtual cities
- Operating in Level A Personal Protective Equipment
- Using actual/simulated equipment
  - Analytical Detectors
  - Sampling Tools
  - ICAM
  - Multi Rae
  - M22 ACADA
  - RADIAC sets

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Soldier in immersive unit

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Fire team training together

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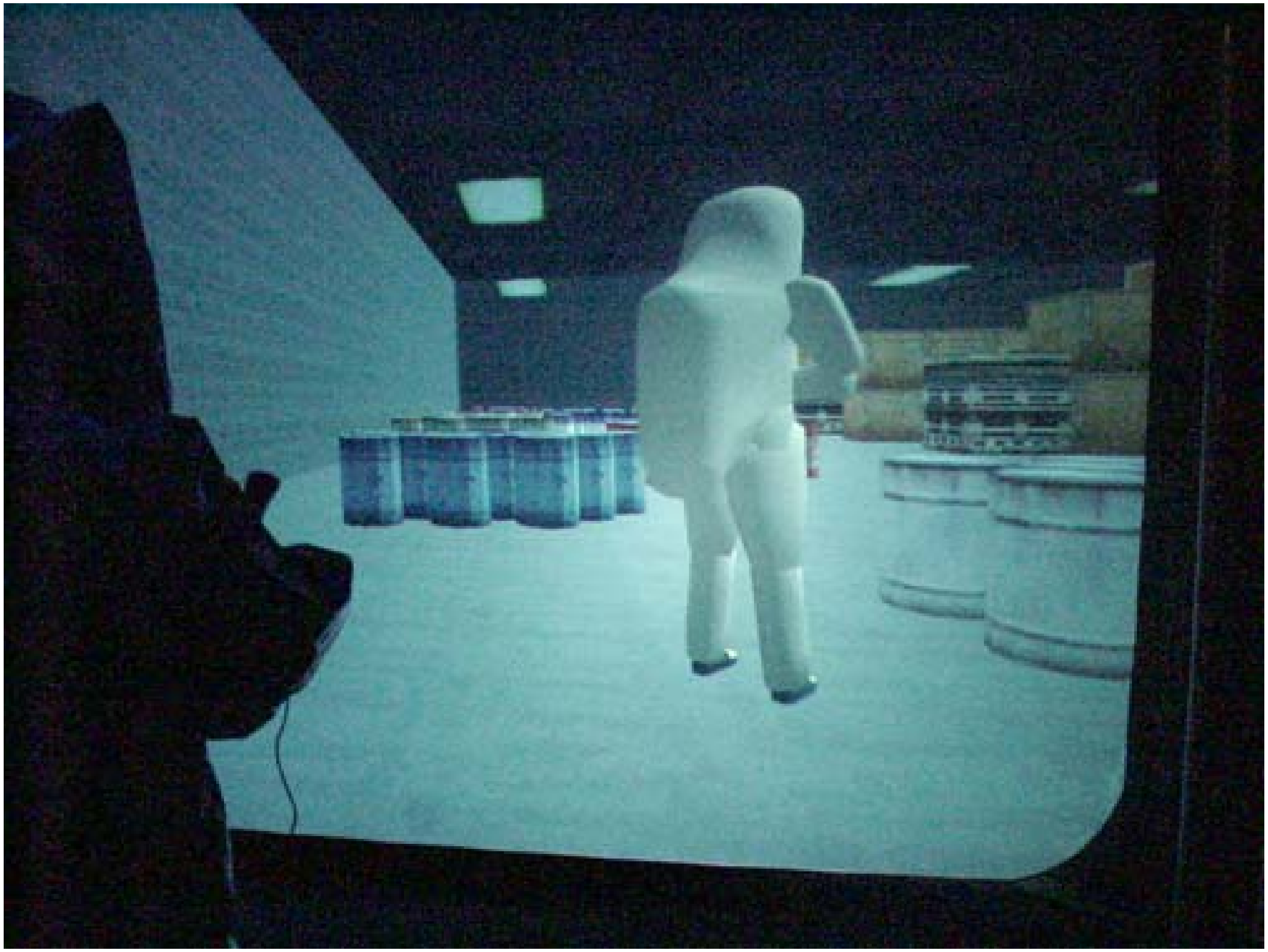

Participant (left) in immersive unit, with view of partner

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Immersive Station Capabilities

- Navigate through virtual environment. In buildings, up and down stairways, into subways, etc.
- Utilize mockup sensor to detect and identify chemical (and/or biological) contaminants
- Allows trainee to wear full protective clothing
- Trainee receives simulated sensor readings on screen
- Drop flags for marking/identification
- Mark doors / walls (X for searching)
- Drop/deploy ACADA sensors
- Pick-up, carry and drop objects (briefcases, etc.)
- Open/close doors
- Record/log events for playback (AAR)

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Third party/instructor view of participants

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Instructor's view of scenario

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Trainee's view with chemical meter

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For further information, contact:

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Director, Business Development

Reality Response

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ALGORITHMICALLY GENERATED MUSIC ENHANCES VR DECISION SUPPORT TOOL

Dr. Panaiotis
Department of Music &
Department of Electrical and Computer Engineering
The University of New Mexico

Steven A. Smith
Los Alamos National Laboratory

Victor M. Vergara and Shan Xia
Department of Electrical and Computer Engineering
The University of New Mexico

Dr. Thomas P. Caudell
Department of Electrical and Computer Engineering &
Center for High Performance Computing
The University of New Mexico

CB Defense Decision Support Tool

Scientists

Engineers

Historians

Political Scientists

Biochemists

Knowledge engineers

Mathematicians

Cognitive Psychologists

Economists

Computer Engineers

Artists

University Partnership Team

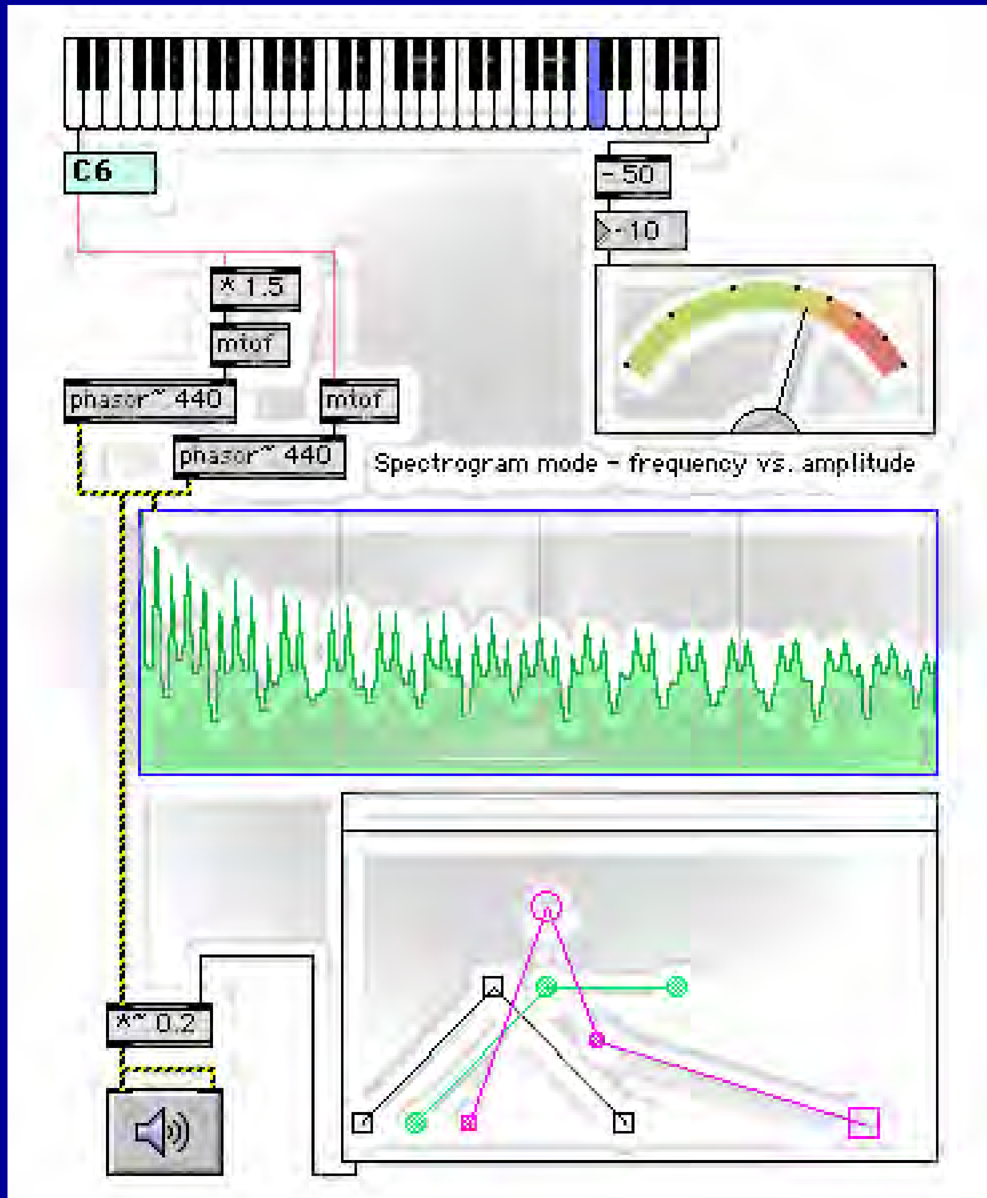
UNM – Frank Gilfeather, Thomas Caudell, Panaiotis, Tim Ross, Mahmoud Taha

NMSU – Jim Cowie, Chris Fields, Hung Nguyen , Bill Ogden, Ram Prasad

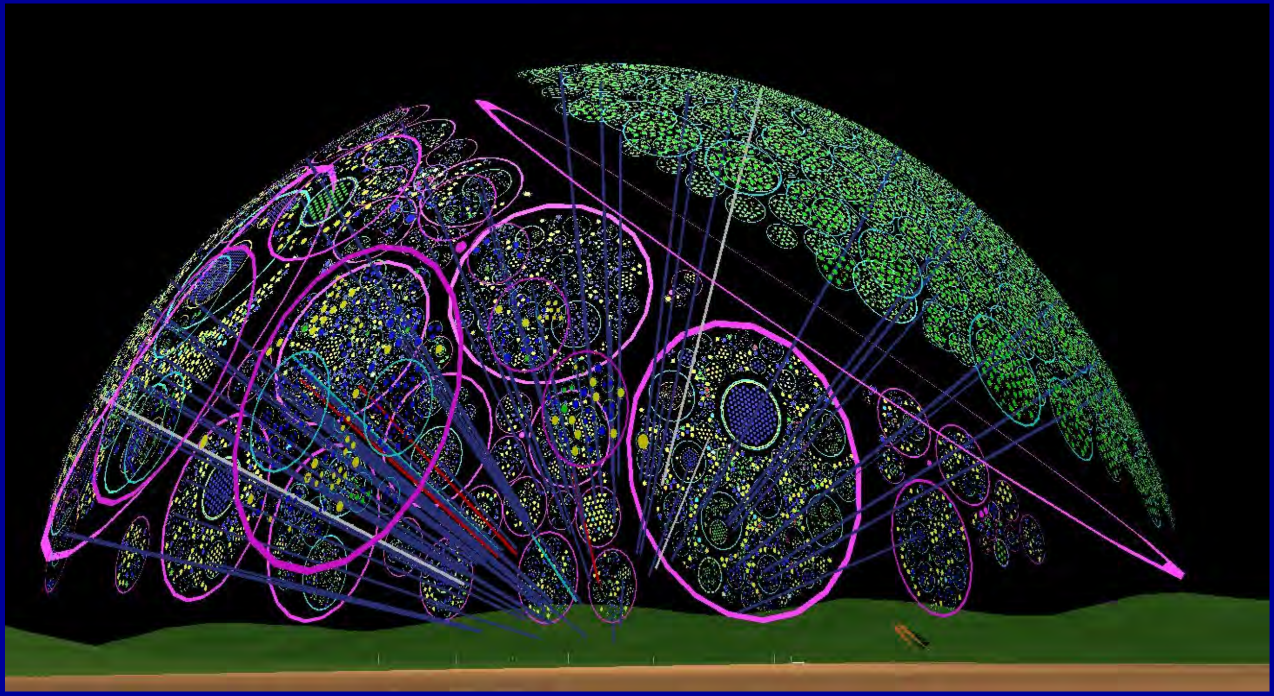
MIIS – Gary Ackerman, Markus Binder, Sundara Vadlamudi

Engages a broad-based team of creative professionals

Science Serving Art

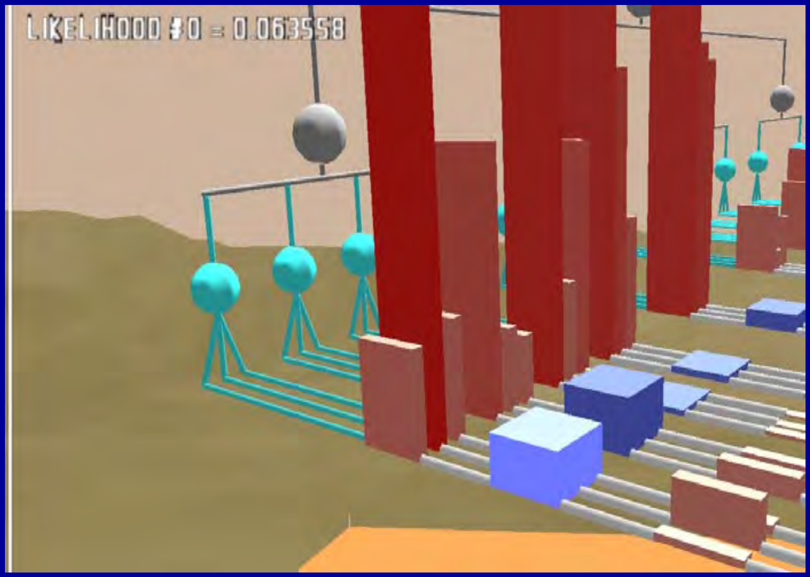


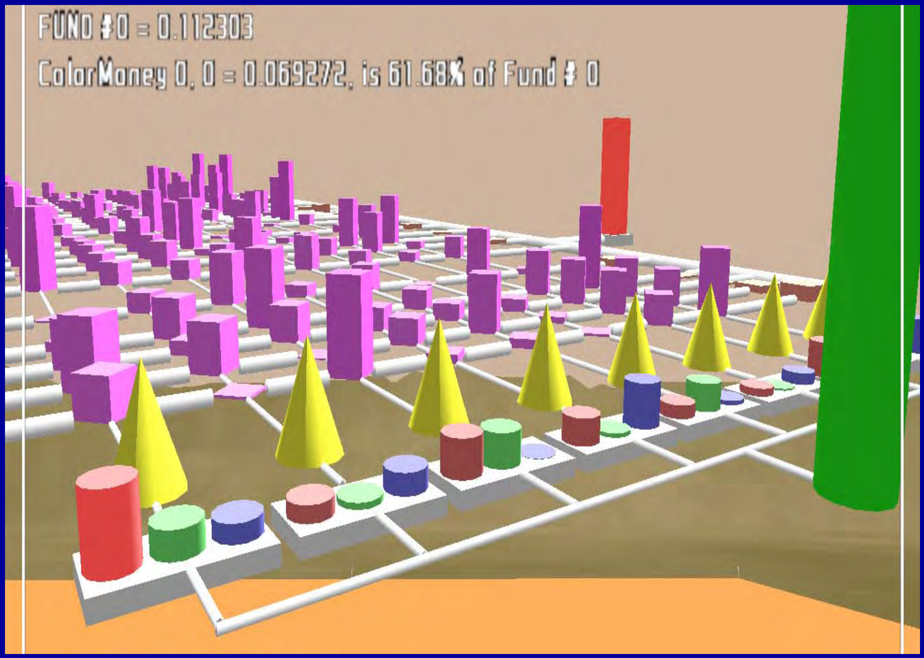
Art Serving Science



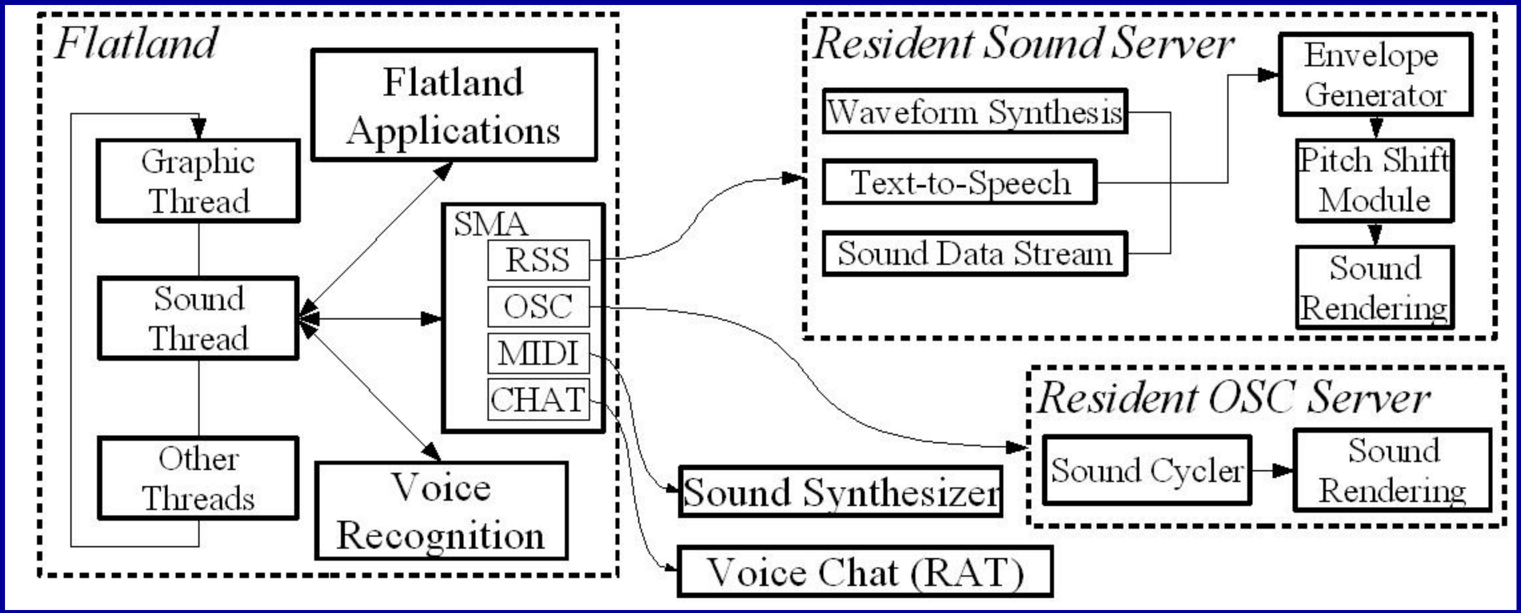
Scientist Serving Pasta

Visualization of Mockup System (1st Generation)

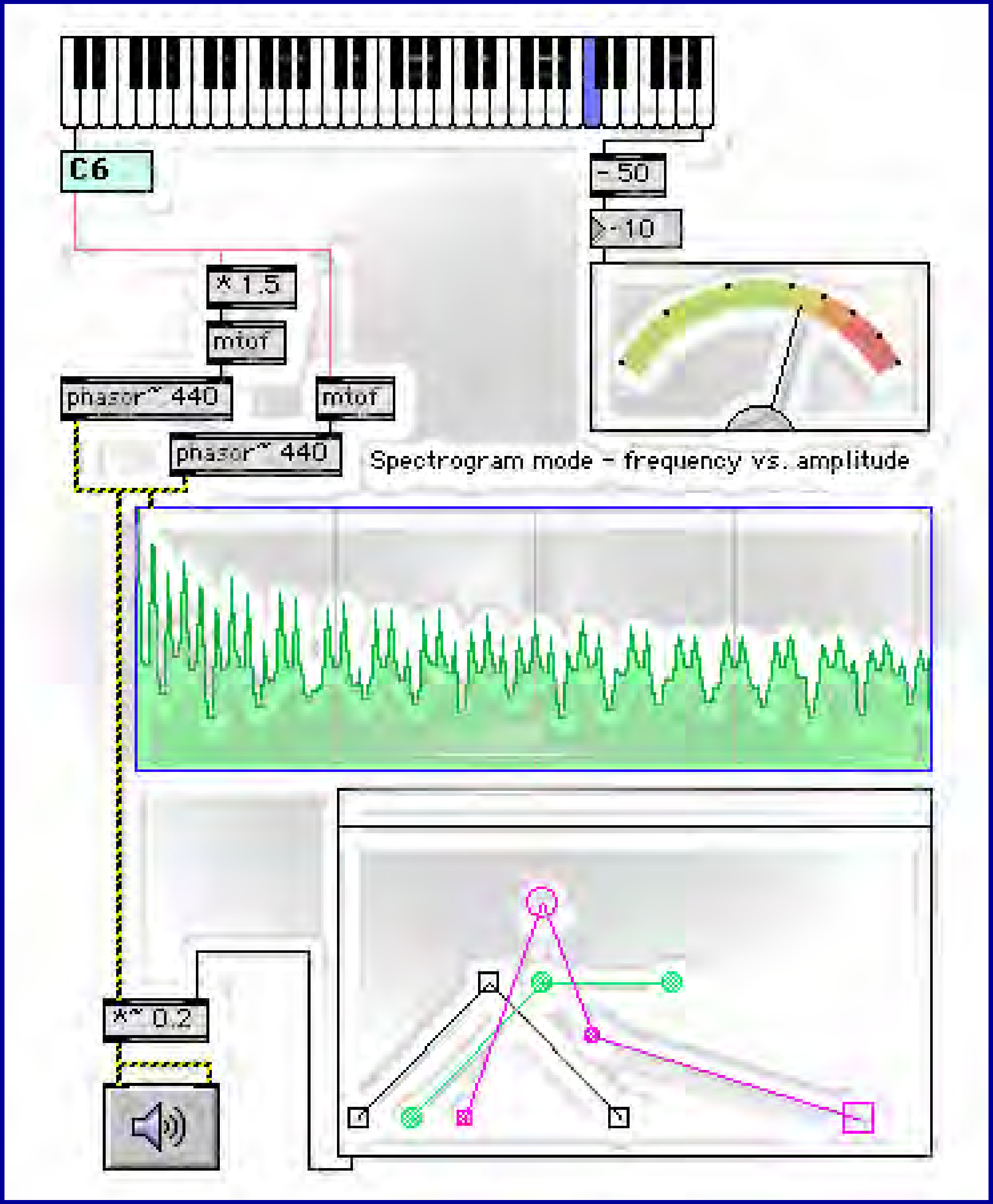




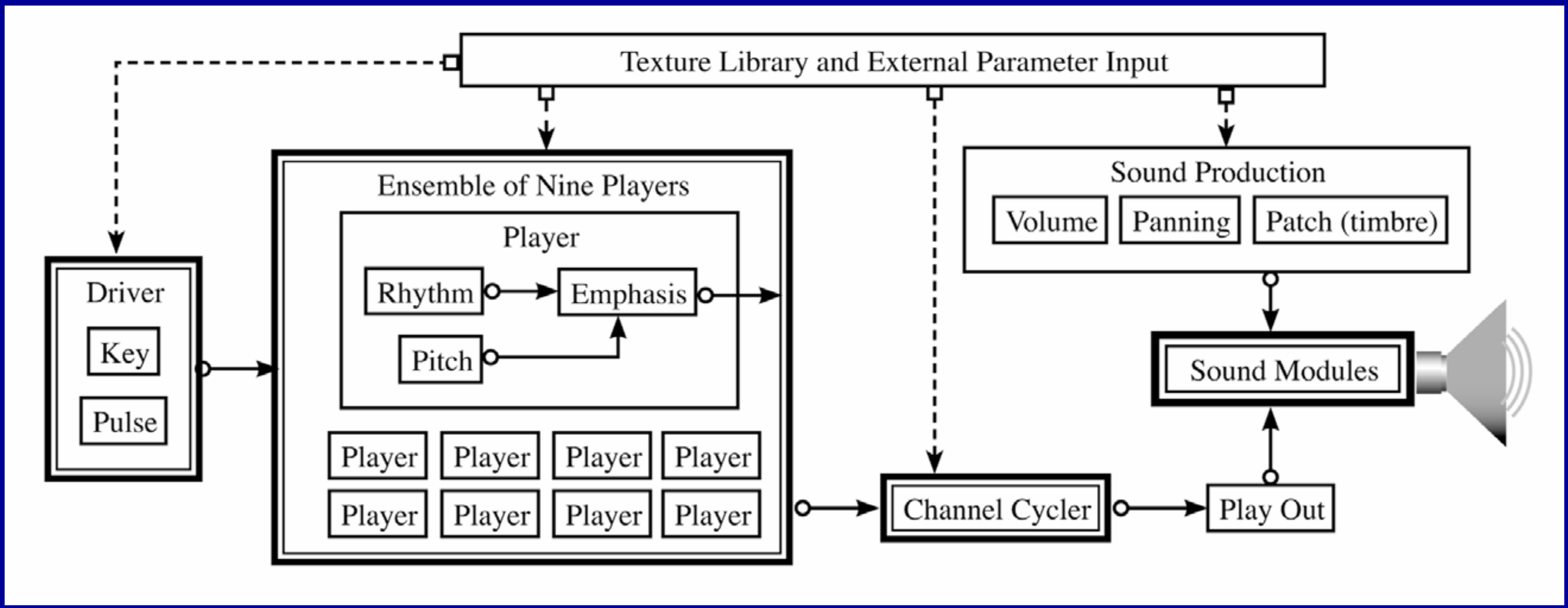
Flatland Sound Services



Max/MSP


C6
- 50
> -10
* 1.5
mtof
phasor~ 440
mtof
phasor~ 440
Spectrogram mode - frequency vs. amplitude
*~ 0.2

SoundCycler Architecture



Six Music Functions in DST

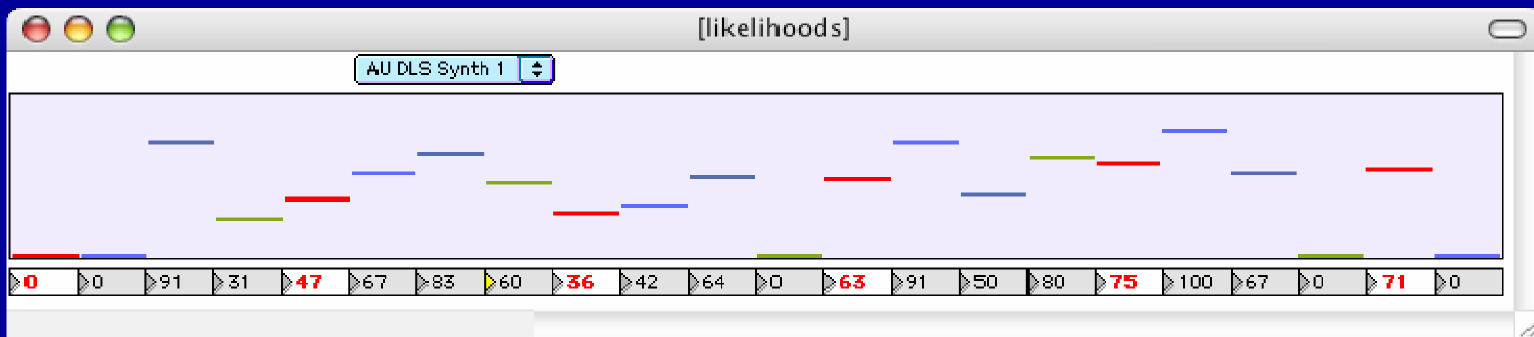
1. The music provides an appropriate ambience to the task at hand
2. The music displays user adjustable input values
3. The music provides user activity feedback
4. The music provides cues for orientation in the virtual environment
5. The music characterizes the data
6. The music provides a means to analyze the data

Musically Represented Data

The music represents five classes of data in the DST:

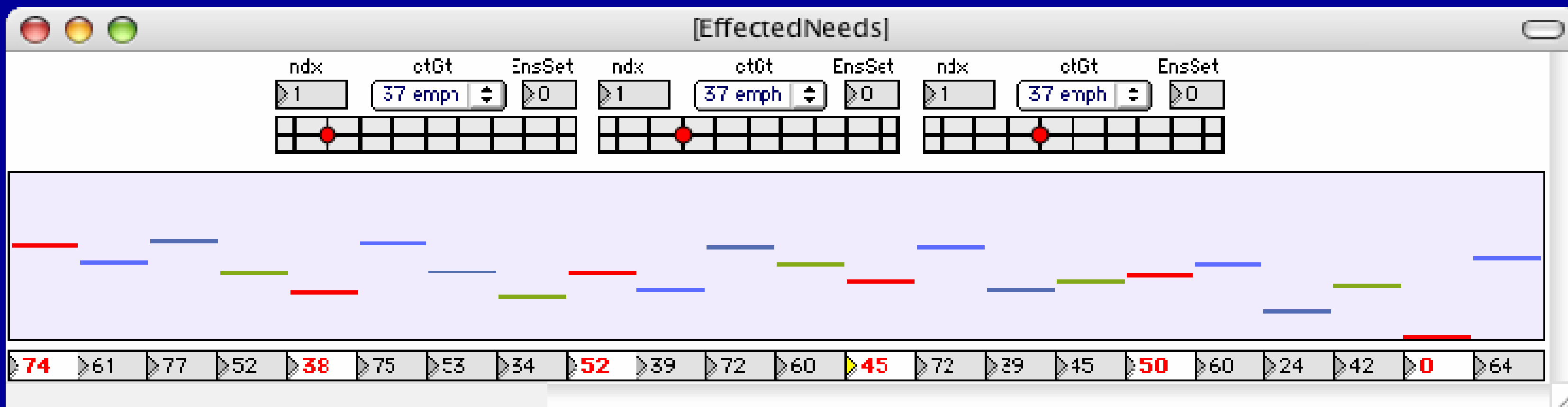
1. **A twenty-two-element scenario likelihood vector**
2. **A twenty-two-element differential between the likelihood-consequence vector (need for mitigation) and the after-mitigation consequence**
3. **Eight funding levels**
4. **One total funding level**
5. **Final expected consequence value.**

Likelihoods



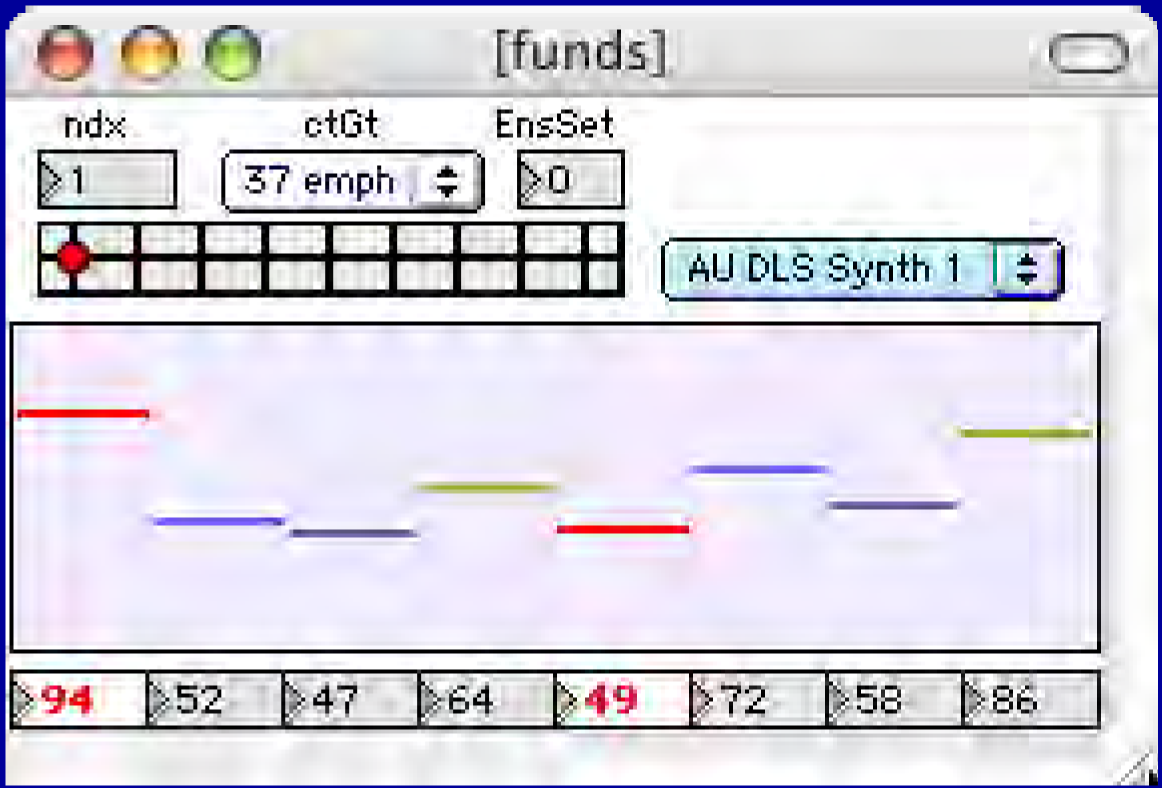
Each horizontal bar represents a likelihood level of a scenario attack within a vector.

Ratios



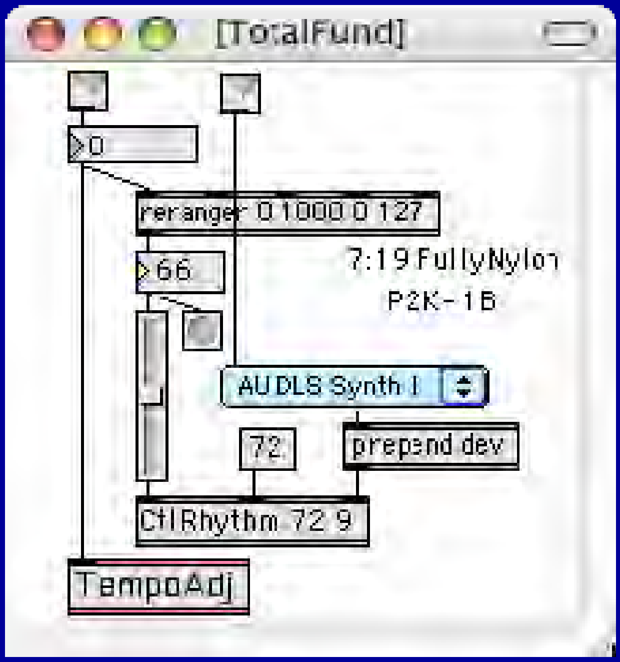
Each horizontal bar represents a ratio difference between consequence-likelihood level and the projected consequence-likelihood after remediation.

Funding Portfolios



Each horizontal bar represents a funding portfolio amount.

Total Funding Limit



The total funding limit affects tempo.
More money is livelier.

Aggregated Final Expected Consequence

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Greater adverse consequence has more persistent bass line.

??

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??

??

??

Modeling and Simulation to Support Virtual Chemical Hazard Environments

West Desert Test Center, Dugway Proving Ground

Jeffery D Peterson, Ph.D.

James A Kleimeyer, Ph.D.

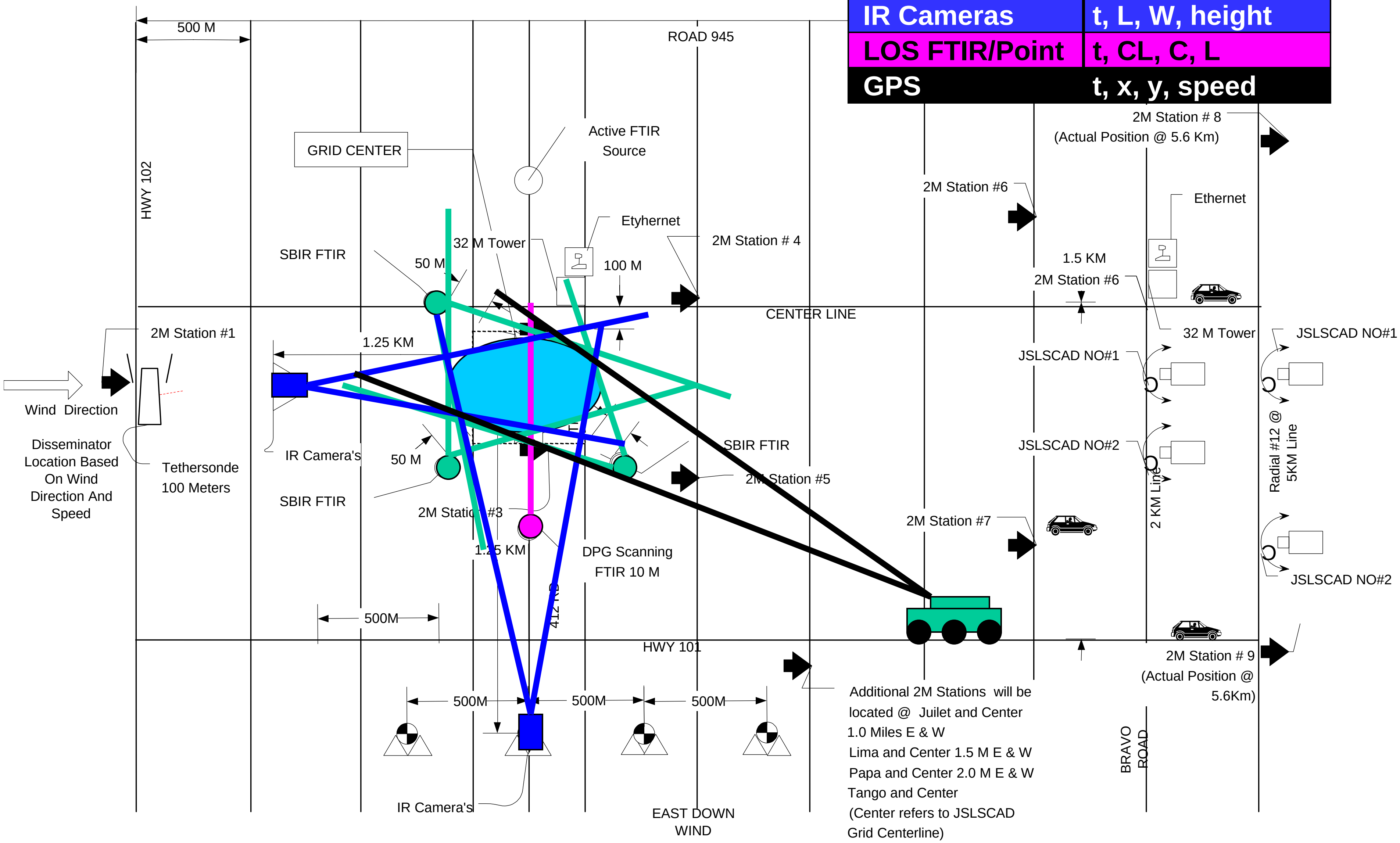
Richard J Green, Ph.D.

West Desert Test Center (WDTC)
Dugway Proving Ground (DPG)

- DoD focal point for test and evaluation (T&E) of chemical and biological (CB) defense equipment
- Testing is conducted with real chemical and biological agents in surety and biosafety level-3 laboratories
- Agent simulants are used in outdoor field testing
- WDTC is developing and acquiring models and simulations that provide digital representation of important test parameters and systems under test

Sensor Testing

Scanning FTIR	t, length, width, C
IR Cameras	t, L, W, height
LOS FTIR/Point	t, CL, C, L
GPS	t, x, y, speed



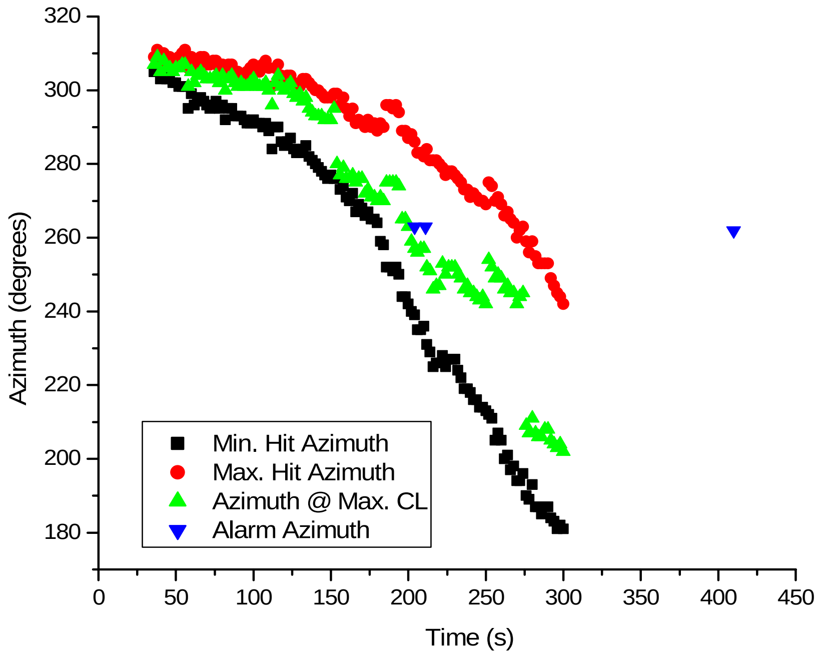
DPG M&S Tools

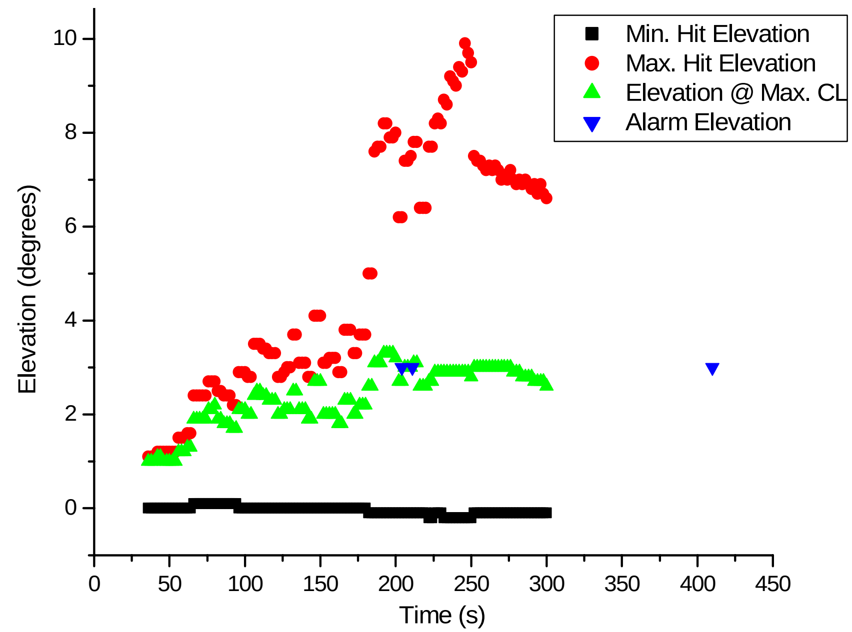
Tool	Purpose
MÄK Data Logger	VCR-like application that **records and plays back** all network traffic
MÄK Stealth	**3-D visualization** application with 3-D entity model support
MÄK Plan View Display (PVD)	**2-D visualization** of the battlefield terrain along with icons representing each entity
Role Player Workstation (RPWS)	Displays **situational awareness** data (Force XXI Battle Command Brigade and Below (FBCB2)) and chemical hazard detection alarms
OneSAF Testbed Baseline (OTB)	**2-D battlefield representation** that allows for scenario generation and battlefield situational development
Player	Provides the ability to **playback** entities, static entities, hazard boxes, hazard puffs, **CB detonations**, and **CB tactical messages**
Dial-A-Sensor (CB DAS)	**Simulation tool** used to represent any general class of CB sensors
Nuclear, Chemical, Biological, and Radiological Environment Server (NCBR)	Physics based environment server used for **hazard propagation**
Live Vehicle Interface (LVI)	Reads **vehicle speed and GPS location** and translocates position onto desired terrain
Ocean, Atmospheric, and Space Environment Server (OASES)	Simulation for creating a 3-D, time-varying, digital representation of the natural **atmospheric environment**
4-Dimensional Weather System (4DWX)	Globally relocatable mesoscale **weather model** with high-resolution forecast capability
CB Analyzer	Performs **“what if” analyses** of stationary and mobile CB sensors
Exposure Toxicity Server (ETS)	Tracks the **CB exposures** of each entity

Post-Test Data Analysis

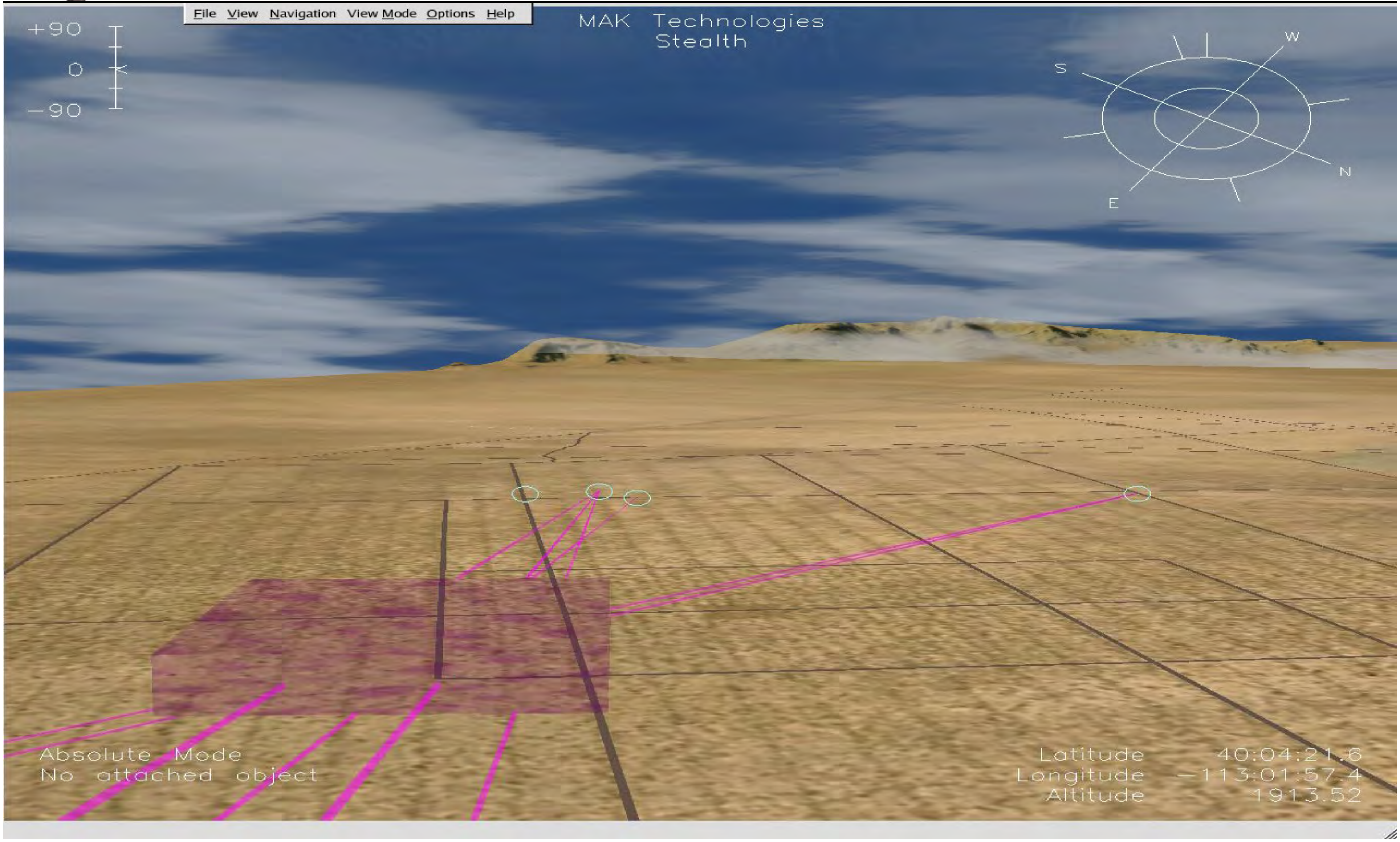
- CB Analyzer is a graphical post-test data analysis tool developed to provide:
  - Concentration
  - Target Location (azimuth, elevation)
  - Ranging (distance to hazard)

Analyzer Data Plots		
Ordinate	***Abscissa***	***Description***
Max CL	Time	Max detected CL values
Azimuth	Time	Azimuth angles for max CL values
Elevation	Time	Elevation angles for max CL values
Azimuth	Time	Max/min azimuth angles that hit the hazard
Elevation	Time	Max/min elevation angles that hit the hazard
Distance	Time	Measured distance through the hazard





Test Data Visualization



Distributed Test Event 5

- Dugway personnel recently participated in Distributed Test Event 5 (DTE 5)
  - Multi-Service Distributed Environment (MSDE)
    - Army, Navy, Air Force
  - Cross Command Collaborative Effort (3CE)
    - Army Test and Evaluation Command (ATEC)
    - Training and Doctrine Command (TRADOC)
    - Research, Development, and Engineering Command (RDECOM)

- Both DTE 5 events were conducted in a classified (*Secret*) environment
- Use live, virtual, and constructive assets in a mock battle scenario
- Conducted on Southwest Asia terrain
- Goal to mirror Future Combat Systems (FCS) Experiment 1.1

DTE 5: MSDE Participants

AIR FORCE - DMOC

DMOC - Kirtland AFB, NM

SIMAF – Wright-Patterson AFB, OH

46thTW – Eglin AFB, FL

19 SOS - Hurlburt Field, FL

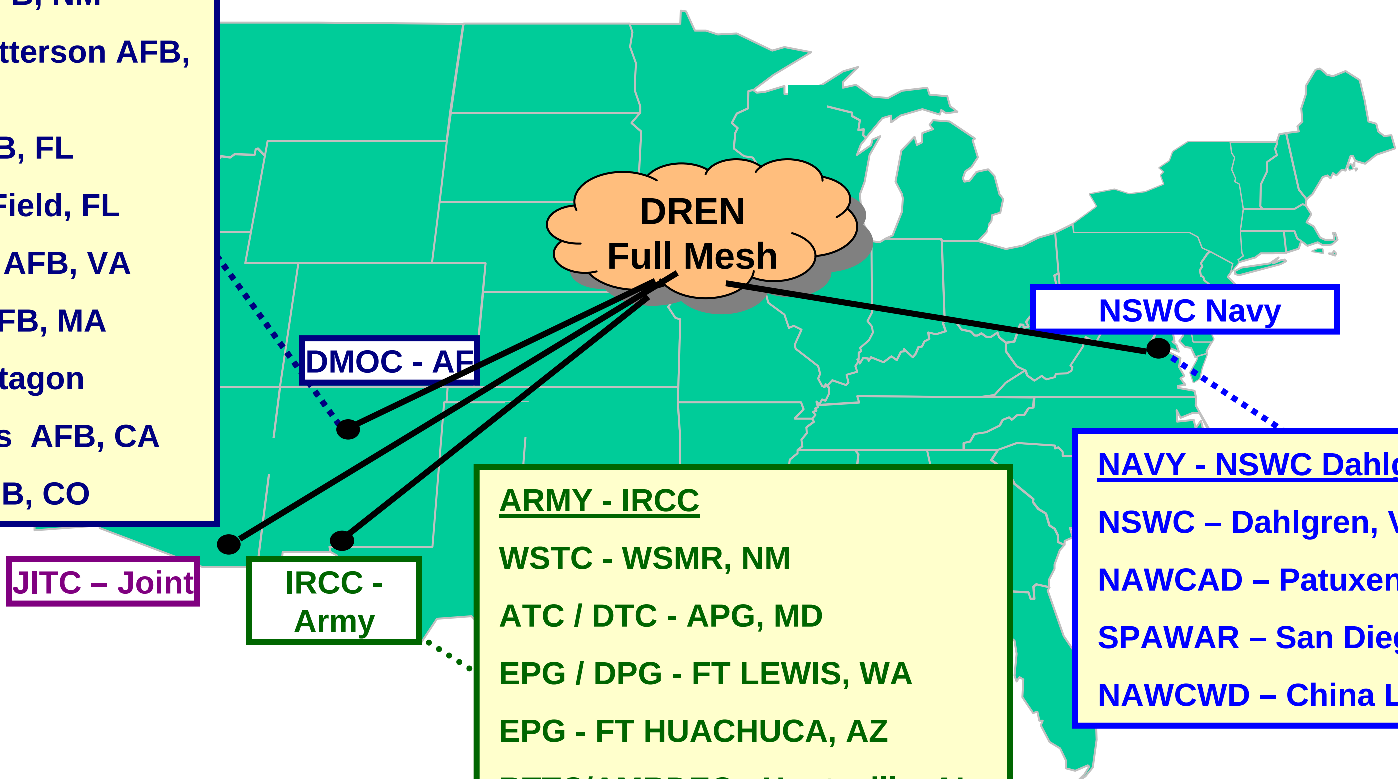
CAOC-X – Langley AFB, VA

CEIF – Hanscom AFB, MA

AFAMS-CVC – Pentagon

SWC – Los Angeles AFB, CA

SWC – Schriver AFB, CO



ARMY - IRCC

WSTC - WSMR, NM

ATC / DTC - APG, MD

EPG / DPG - FT LEWIS, WA

EPG - FT HUACHUCA, AZ

RTTC/AMRDEC - Huntsville, AL

JPSD JPO / NVESD – FT Belvoir,, VA

NAVY - NSWC Dahlgren

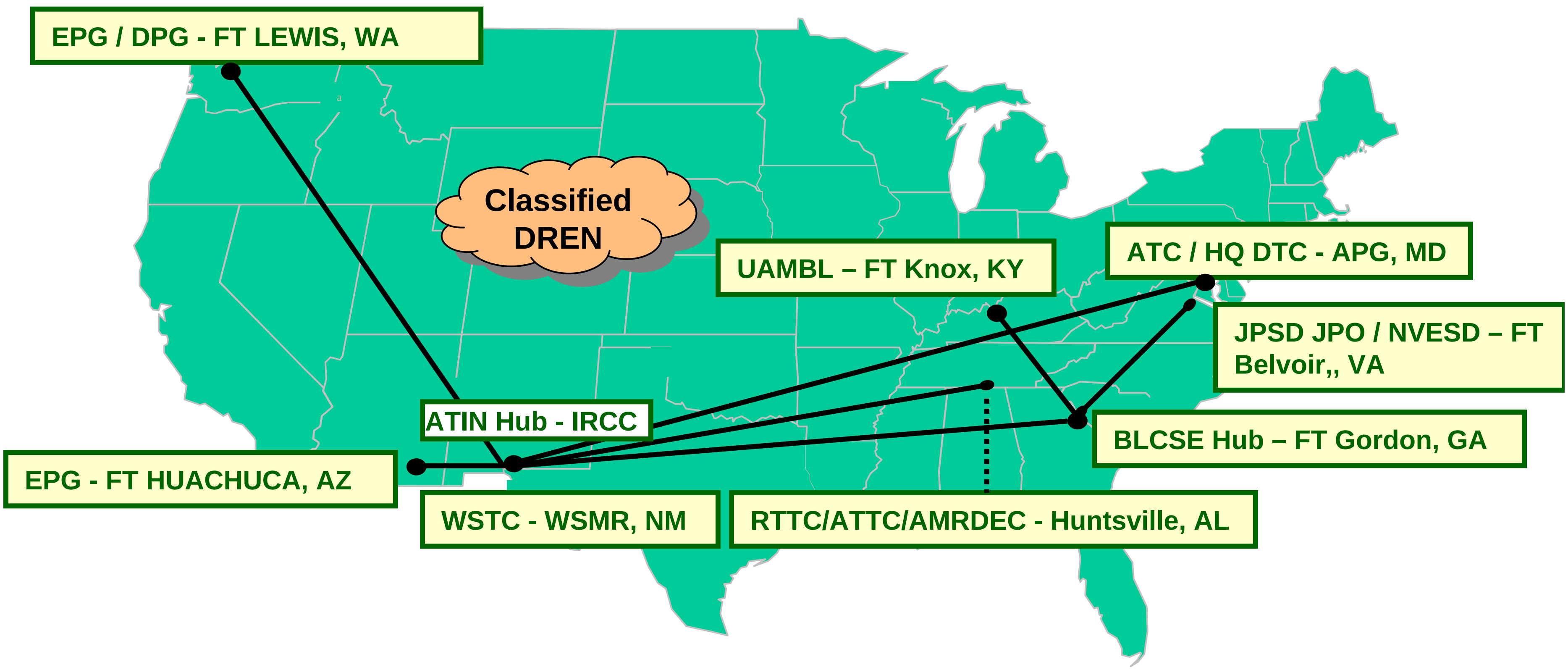
NSWC – Dahlgren, VA

NAWCAD – Patuxent River, MD

SPAWAR – San Diego, CA

NAWCWD – China Lake, CA

DTE 5: Army 3CE Participants



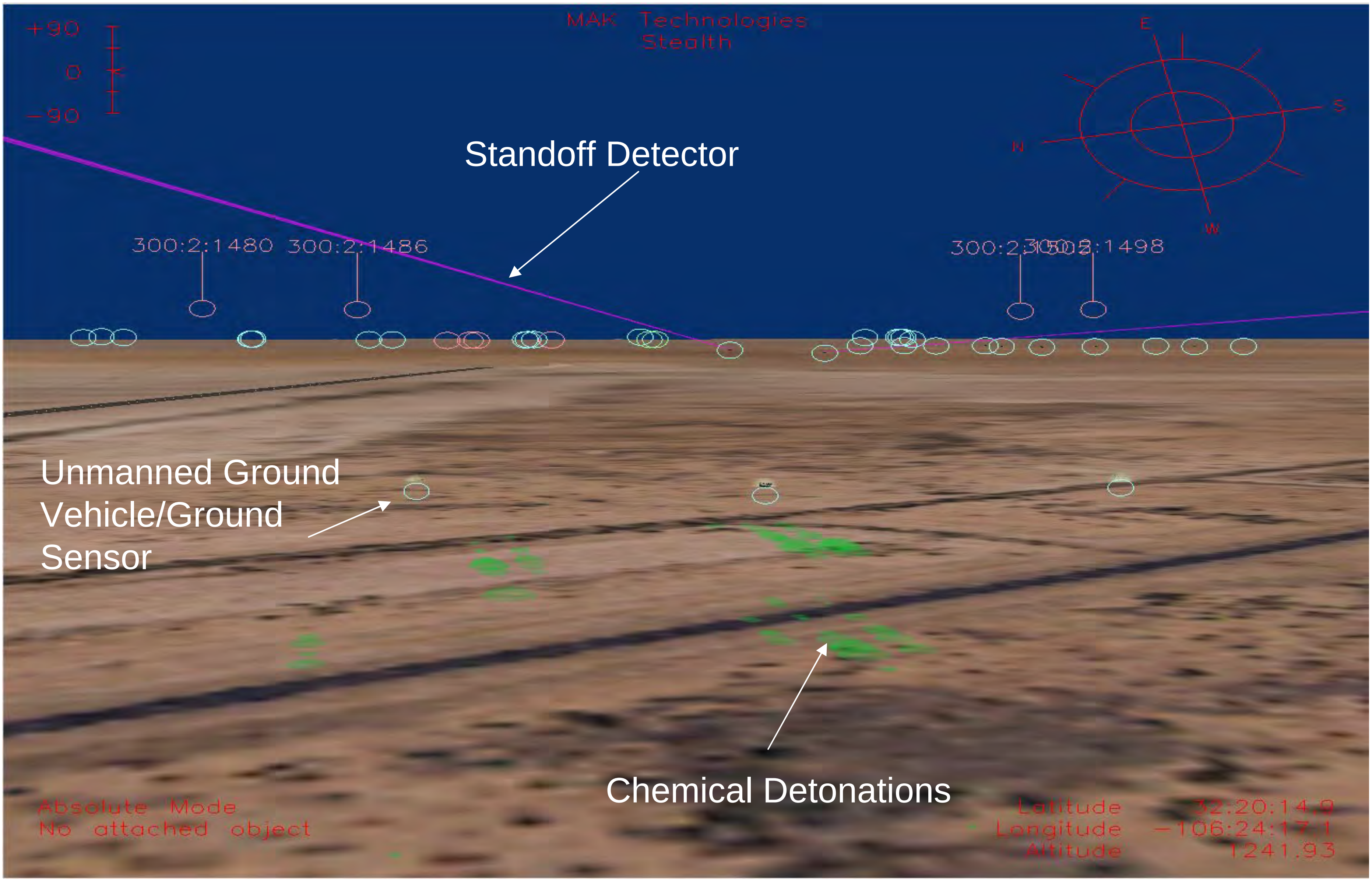
DTE 5 by the Numbers

Statistic	3CE	MSDE
1. Duration of scenario:	120 minutes	150 minutes
2. Tactical Missions:	FCS Exp 1.1	JSEAD, JAEA, JFIRES, JCAS, JCSAR
3. Number of sites participating / networked:	13 / 8	USA = 11 / 6, USN = 4, USAF = 8
4. Number of different time zones for sites:	5 times zones	5 time zones
5. Number of entities:	600	650
6. Number of simulations and tools:	49 different simulations, multiple instances	61 different simulations, multiple instances
7. Number of warfighters / threat players:	RTTC = 33, ATC = 16, UAMBL = 6	USA = 49, USAF = 12 , USN = 8
8. Number of integration events (spirals)	10	10
9. Network Bandwidth Utilization:	Never more than 25%	Never more than 25%
10. Command / Service Site Accreditation:	RDECOM = FEB – JUL TRADOC = Already Est. ATEC = FEB – MAY	USN = FEB – JUL USA = FEB – JUL USAF = Already Est.
11. Tasks in Time Ordered Events List:	2416	3473

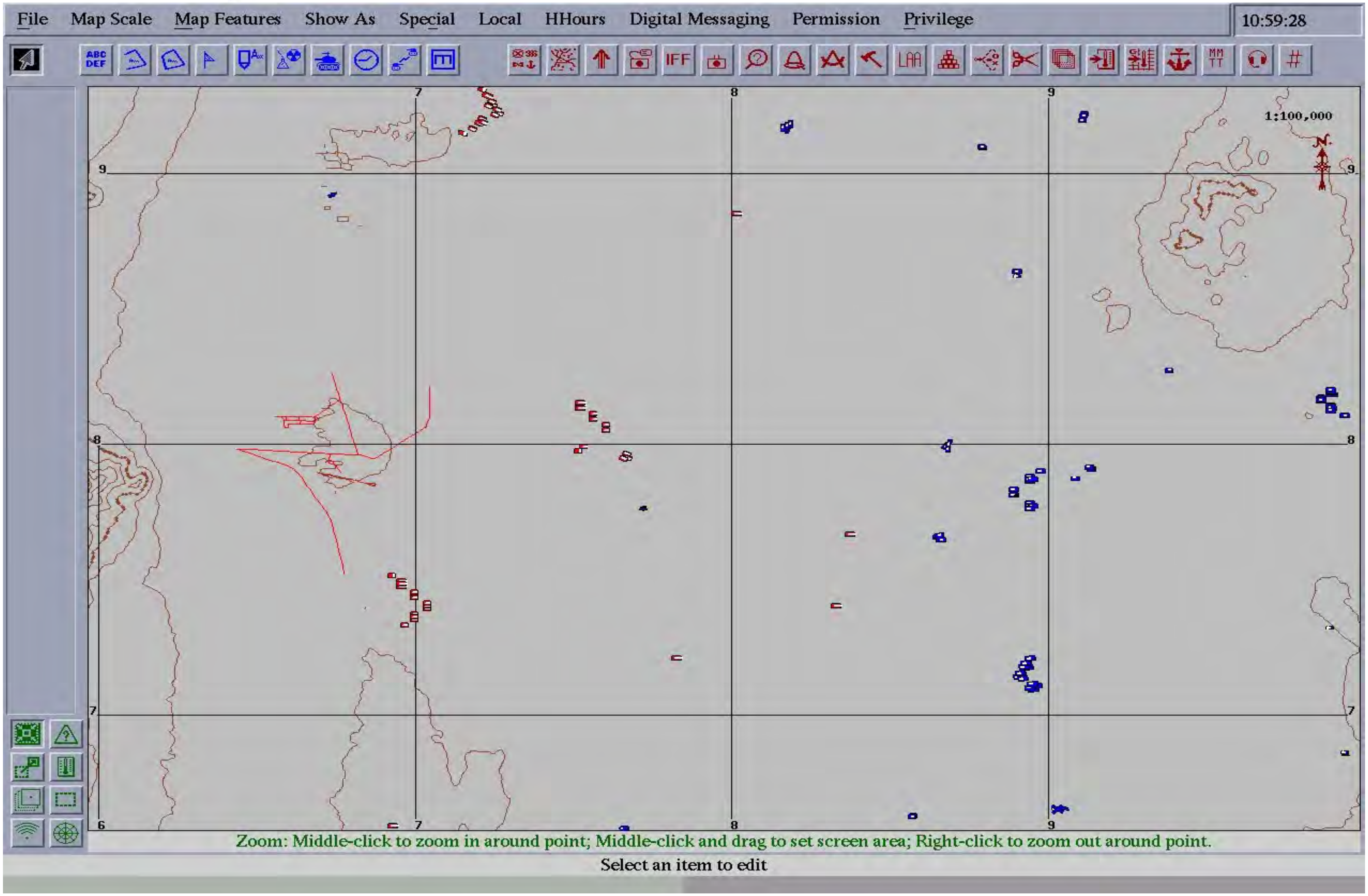
Dugway Roles in Distributed Testing

- Provide simulated chemical agent release
- Provide weather
- Provide agent propagation model
  - Subject to weather, terrain
- Provide agent exposure monitoring
  - Who was exposed? When? How much? Status?
- Provide virtual chemical agent sensors
  - 3 Joint Services Lightweight Standoff Chemical Agent Sensors (JSLSCAD)
  - 3 ground deposition sensors

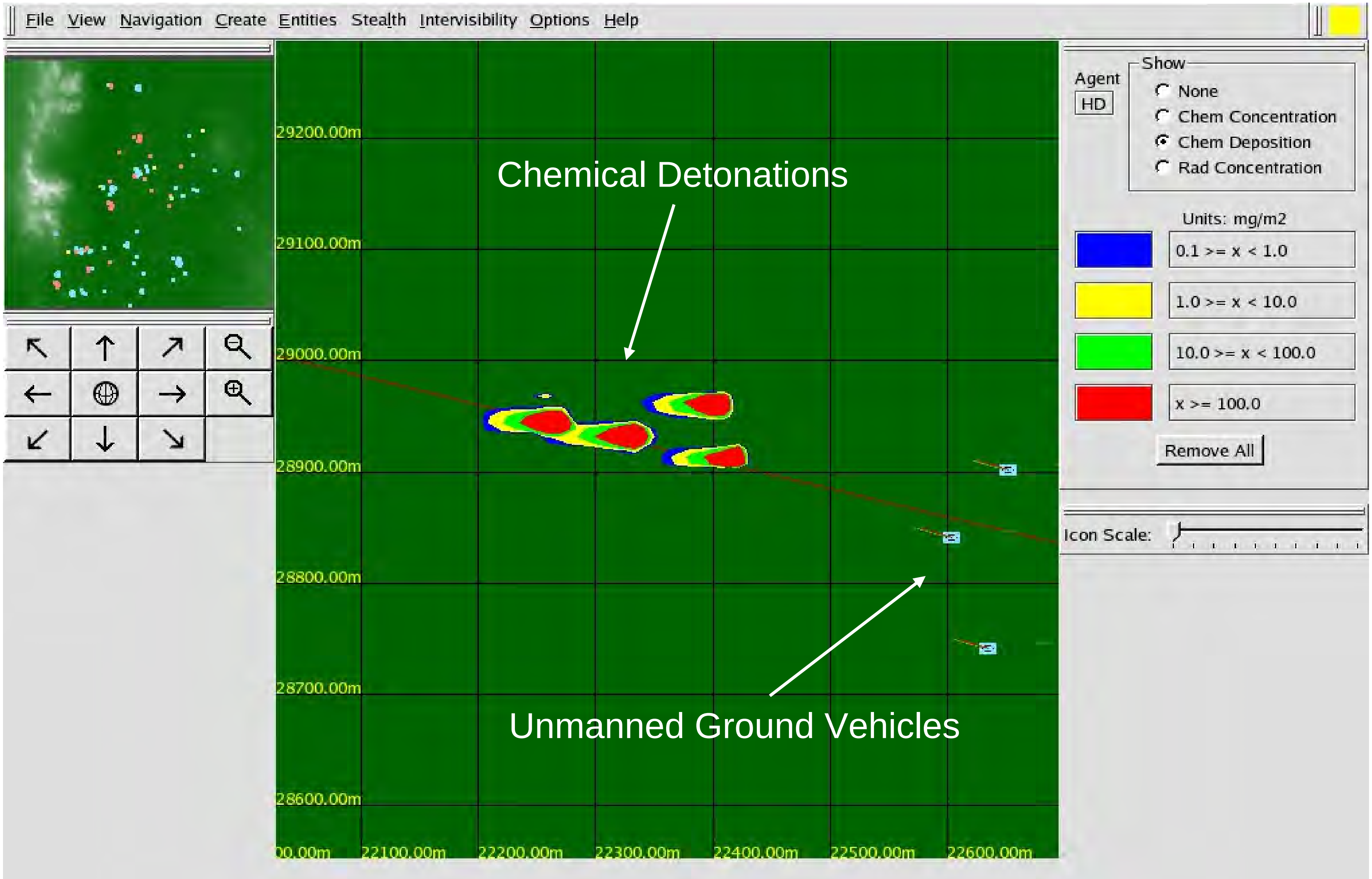
Stealth – Visualization Tool



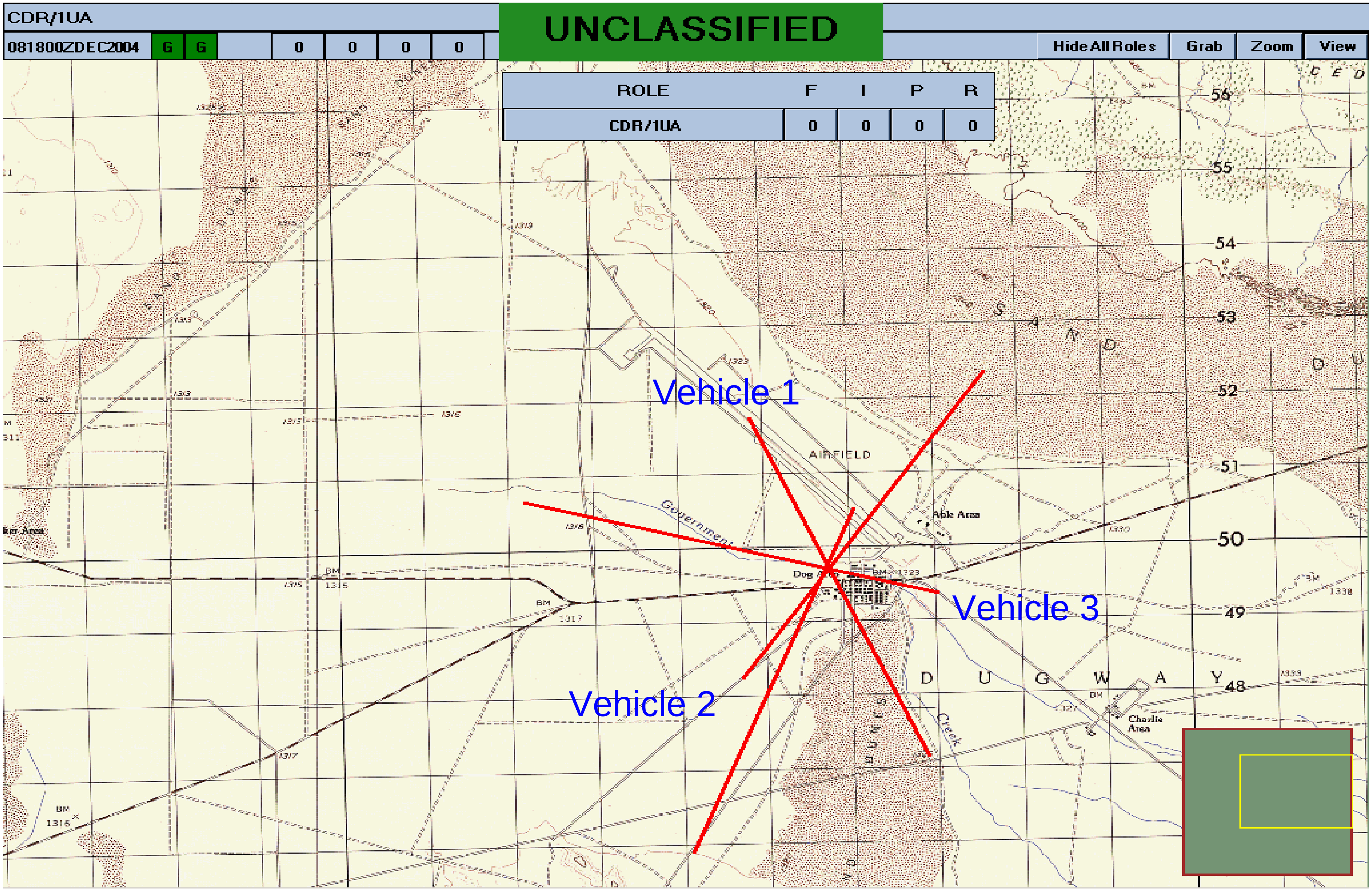
OTB – Visualization and Planning



PVD – Visualization and Information



RPWS—Situational Awareness



Future M&S Plans at Dugway

- Continue use of tools for post test data analysis
- Support classified testing
- Support future distributed test events
- Distribute live DPG test data to customers/others
- Begin development of live (real-time) test data analysis
  - Stream live field data into Distributed Test Control Center (DTCC)
  - Fusion of sensor data
- Begin development of overarching protection models
  - Individual, Collective
- Provide test support for Joint Warning and Reporting Network (JWARN)

SensorView™

Wirelessly Enabling Legacy Sensor Systems For Rapid Deployment And Monitoring

Presentation for

Science and Technology for Chem-Bio Information Systems Conference

Ricciardi Technologies, Inc (RTI)

Agenda

- Introduction
- The Problem
- Identified Challenges
- A New Solution
- Results Achieved
- What's Left?
- Open Discussion

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RTI The Company

SensorView™

- **Incorporated in 1992**
  - Woman-Owned Small Business
  - Under 50 Employees
  - Employee Stock Ownership Program
  - Profitable Since Inception and Debt Free
- **Headquartered in Virginia with key clients**
  - SPAWAR
  - DHS-HSARPA
  - Sandia National Labs
  - RDECOM - Edgewood
  - PEO-CBD
  - DTRA
- **Core Competencies**
  - HW/SW Design & Development
  - Mgmt/Technical Services
- **SensorView® Product Suite**

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RTI CBRNE Experience

- Joint Biological Point Detection System (JBPDS) EMD
- JBPDS Block II Briefing
- Multi-Purpose Integrated Chemical Agent Detector (MICAD)
- Biological Aerosol Warning System (BAWS 97/98)
- Biological Agent Warning System (BAWS III)
- Automated Carrier Quality Control System (ACQCS)
- Joint Warning and Reporting Network (JWARN) Prototyping
- Joint Service Installation Pilot Project (JSIPP)
- JPEO-CBD CBRNE Sensor Sim. Suite for Generic Sensor Emulation


JBPDS

BAWS 97/98


MICAD


BAWS III


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The Problem

- Massachusetts National Guard 1st WMD Civil Support Team deployed several GID-3 CWA point detectors to aide first responder security during special events.

- Operators had to be collocated with sensors to report sensor information to command post via radio. This is inefficient and puts our national guardsmen in harm's way.

- The CST desired a low-cost solution to wirelessly network the GID-3 in order to remove the human-in-the-loop requirement.

- The solution had to allow for the addition of future sensors as CST resources are expanded based upon mission requirements.

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Identified Challenges – High Level

- **Rapid Deployment – The CST required a system to be mobile and transportable to multiple event locations. The system must be automated and deployable by a small team within a half hour.**

- **Battery Powered – Without fixed installations, wired power cannot be guaranteed. The remote devices must operate on battery power for at least 8 hours.**

- **Data Response Time – With CWA, seconds mean lives. Data must be presented to the operator quickly via an event-driven interface.**

- **Data Precision – All data provided by the sensor interface must be presented to the operator in a clear and concise manner, preferably in the same manner that the sensor itself uses.**

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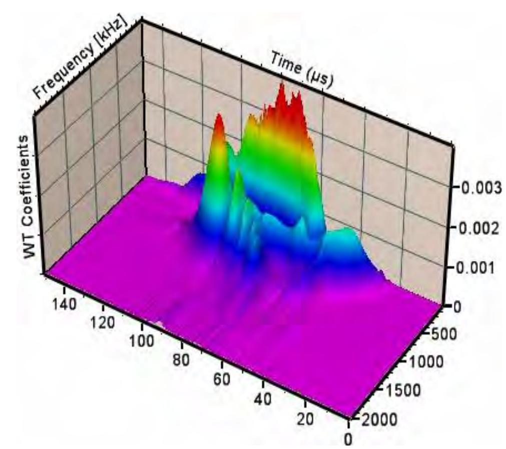
Identified Challenges – Issues

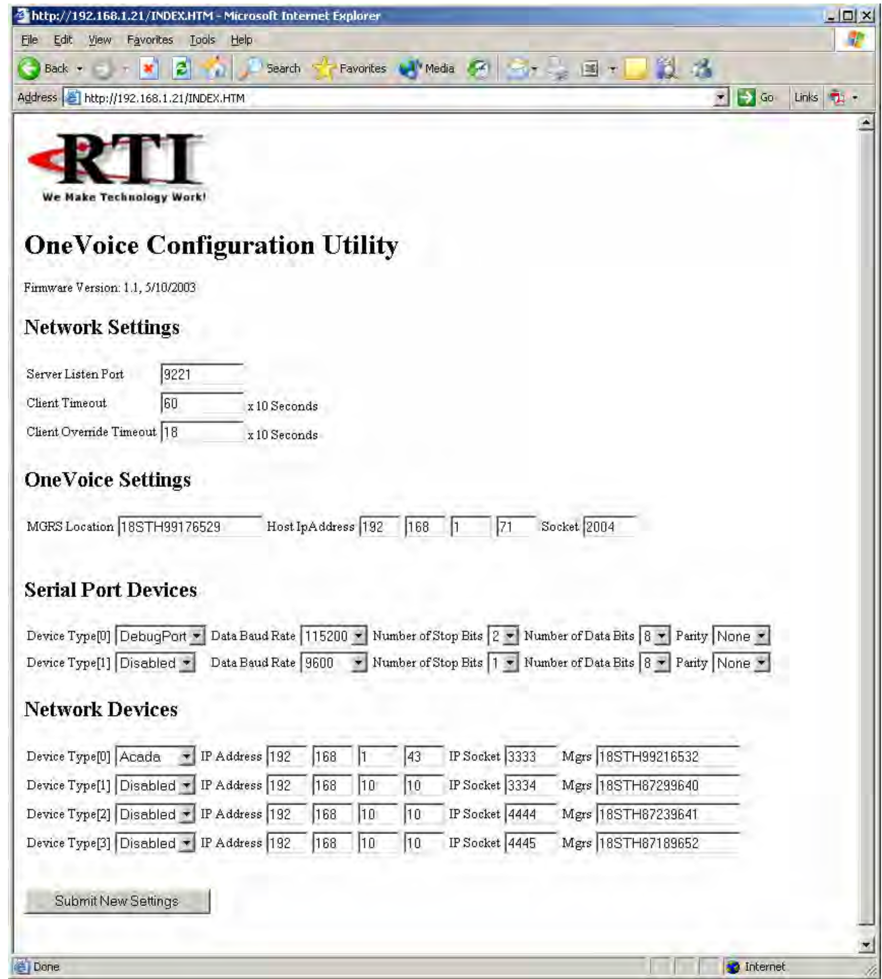
- **Bandwidth Utilization – Most native sensor protocols are not compact enough to support efficient radio communications with repeaters in the loop. A compressed protocol is required to maximize bandwidth usage.**
- **Radiated RF Power – To increase range and reliability, configuration must be set to provide the maximum RF power per transmitted bit of data possible. This suggests even lower data transmission rates. 9600 bps is ideal.**
- **Size and Weight – Long range radios require quite a lot of power when transmitting and sealed lead batteries are heavy. Need to minimize radio duty cycle and transmit times in order to minimize battery size and weight.**
- **Network Range – Line-of-site cannot be assumed for deployments within city environments. The radio network must include multiple repeaters capable of multi-hopping to allow for complex deployments.**



SensorView™

A New Approach – OneVoice™

Connects predefined Sensor Devices to the communication protocol of your choice in a low cost form factor.



Ability to pre-process Raw Sensor information to make it meaningful, secure and reduce the network traffic by providing application level data…..

OneVoice™ Details

- Multiple encryption options (N-Bit Key, SSL) keep sensor data secure
- Available interfaces for wireless Ethernet, wired Ethernet, Fiber Optic, or radio modem (Skyline or Freewave) communications links
- Sensor integration platform that supports multiple RS-232, -422, -485, Ethernet, and A2D/discrete (+/-) interface based sensors
- COTS parts that are readily available
- Low power for long battery life (5V DC at 480mA)
- Connects to individual sensors or networks of sensors
- Secure and web-accessible configuration
- Supports secure data access with an XML and SNMP interface
- Extremely small form factor for efficient integration into existing sensors
- Meteorological (Weather) and GPS Sensor Interfaces capable

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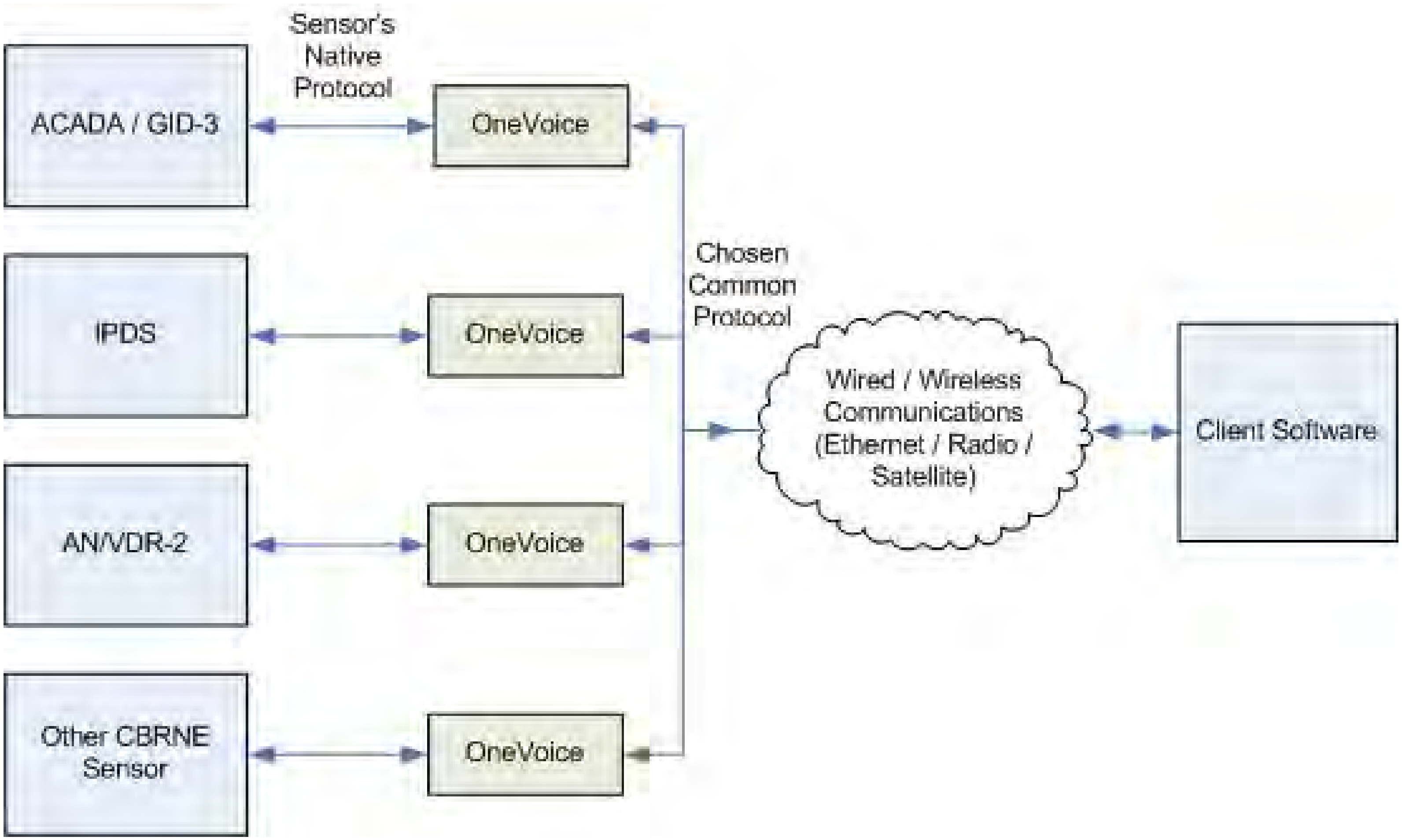
OneVoice™ Network Architecture



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The Sensor Radio Remote System

- Integrated OneVoice™ module, radio, and long-life rechargeable battery.
- Measures only 5” X 9.5” X 6” and is less than 10 pounds – easily transportable with the sensor by one person.
- Converts the native GID-3 protocol from a constant 120 bytes per minute to only 5 bytes sent only when the data changes – an average of 5 bytes per minute.
- Each remote box can also act as a store and forward repeater for other units.
- Average battery charge of over 8 hours.
- Multiple antenna options to support rapid mobile deployments and long-range fixed site installations.
- Data is sent to the command post and displayed at near real-time -- the same time the information is displayed on the sensor itself.
- Open design supports possible addition of other sensors to the network in a similar fashion.

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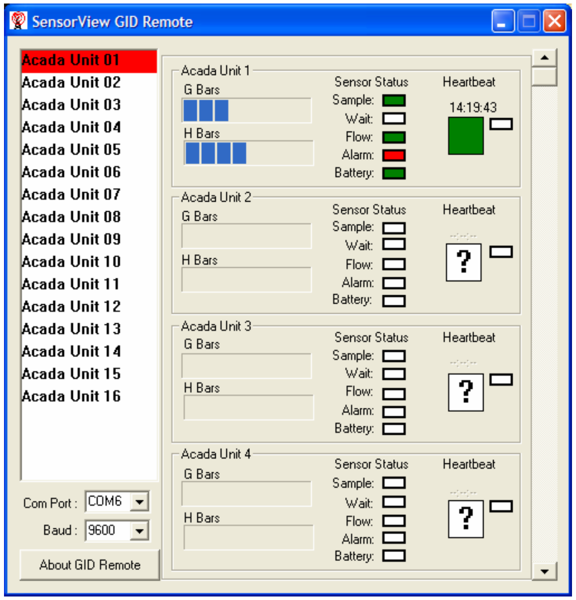
SensorView™

The Sensor Radio Remote System



- Since all sensor data is multiplexed on one frequency, the command post is small and consists of a weatherized radio and laptop.
- Data is displayed to the operator using the same convention that the sensor uses, reducing training time and providing a case-complete view of sensor activity.
- Units are automatically detected and displayed on the screen.
- Communications link health is shown, providing the operator confidence in the network.
- Simple and automated startup requires no operator interaction.
- Alarms are displayed independent of current sensor state to provide the operator a clear view of the over-all operational picture and history.

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Conclusions

SensorView™

- By utilizing the OneVoice™ product the CST was able to solve their immediate problem and allow for a scalable and modular solution for future mission requirements.

- By utilizing the latest commercially available embedded hardware, systems integrators can vastly reduce sensor integration issues by using small focused modules to allow sensors or sensor systems to communicate with a single desired protocol, such as EDXL, CAP, or the Joint CBRN Data Model.

- OneVoice™ devices are commercially available now and are inexpensive.

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Future R&D

SensorView™

- Continue to reduce the size and weight of all system components.
- Integrate additional support sensors into the remote box, such as weather and GPS.
- Provide a hardware option to allow the SRR system to act as a Cross Domain Solution (CDS).
- Provide an integrated GIS toolkit to allow the sensor network to be shown on city maps for first responders.
- Integrated alarm notification via SMS or email to configured distribution lists for cell phones/PDAs.
- Reduce OneVoice™ hardware footprint onto a single DIP to provide easier integration options for sensor manufacturers to embedded protocol independence into their product lines.
- Enhance wireless options to provide interfaces to wireless Mesh networks and 1451 standards when adopted by DoD or Industry.

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SensorView™

Open Discussion

RTI

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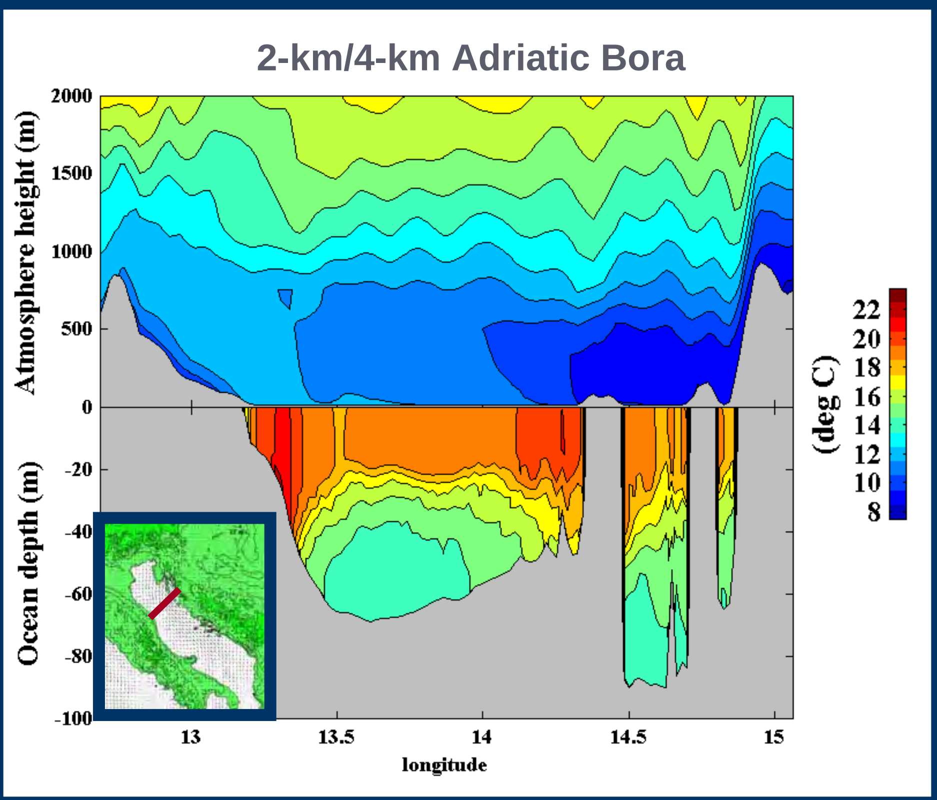
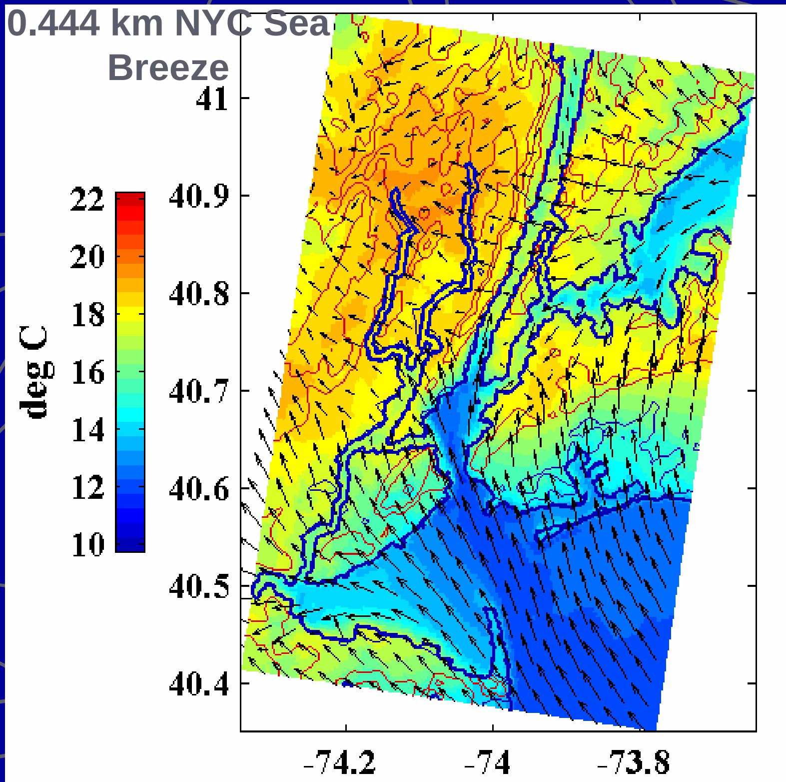
Coupled Air-Sea Modeling for Improved Coastal Dispersion Prediction

Julie Pullen

& Marine Meteorology Division,

Naval Research Laboratory





Outline

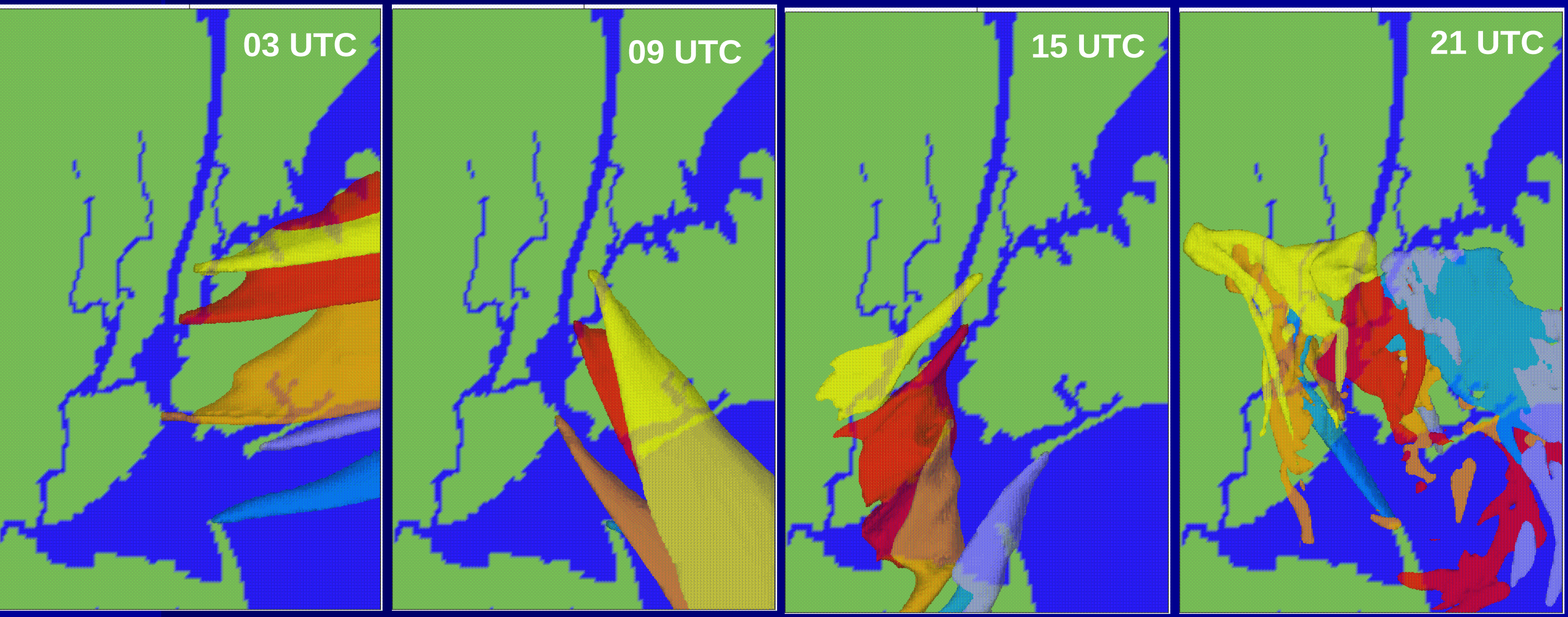
- SST impacts on NYC region during sea breezes

- 2-way air/sea feedback in the Adriatic during strong wind events

Air-Sea Interaction in NYC:
Mesoscale Modeling for CB Threats

Julie Pullen & Teddy Holt
Naval Research Laboratory
Monterey, CA

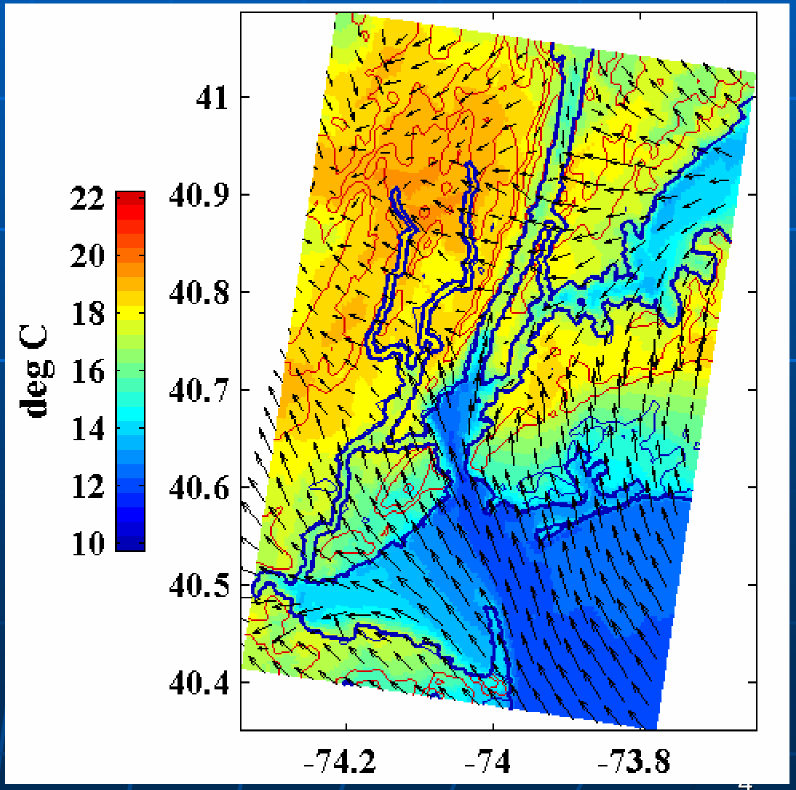
with Alan Blumberg, SIT
Brian Colle, SUNY-Stony Brook
& Marty Leach, LLNL



Mesoscale Overview

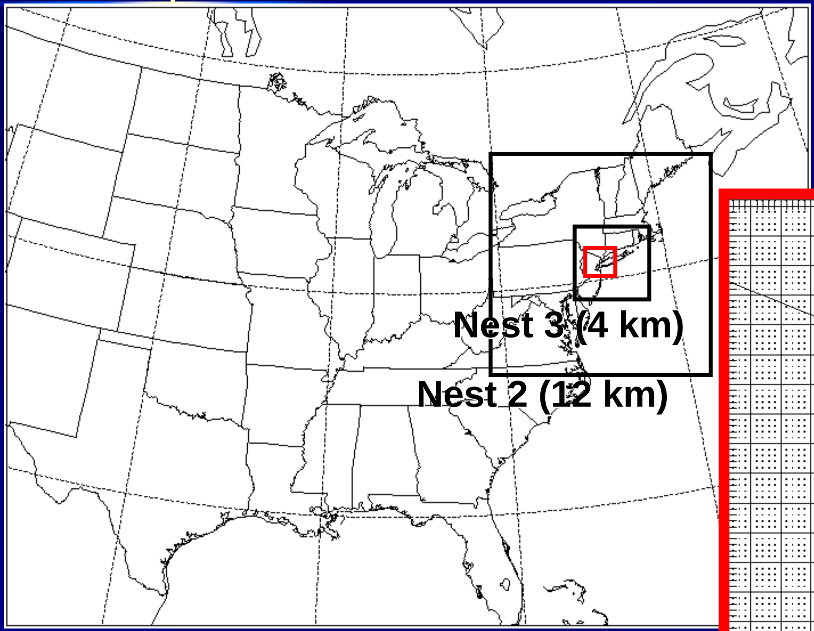
- COAMPS®: data-assimilation modeling system
- 5 nests (36 km to 0.444 km)
- urbanization and time-varying (hourly) realistic SSTs on nests 4 (1.33 km) & 5 (0.444 km)

sea breeze forecast (nest 5)

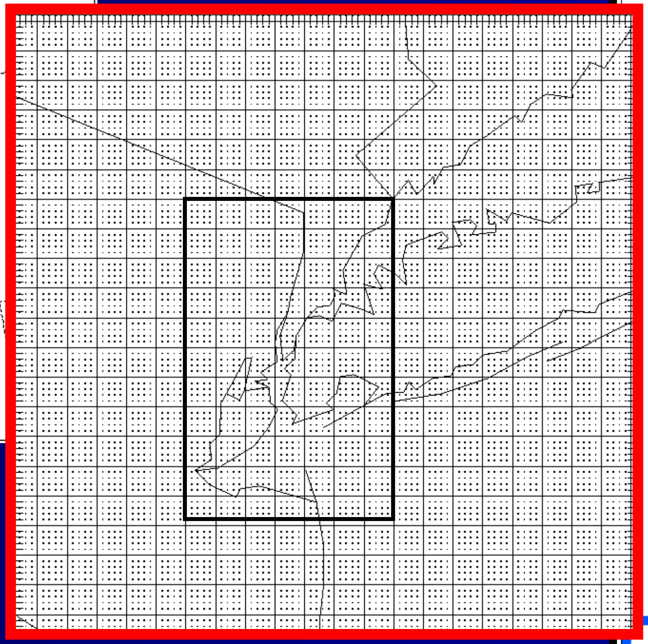


NYC Mesoscale Modeling

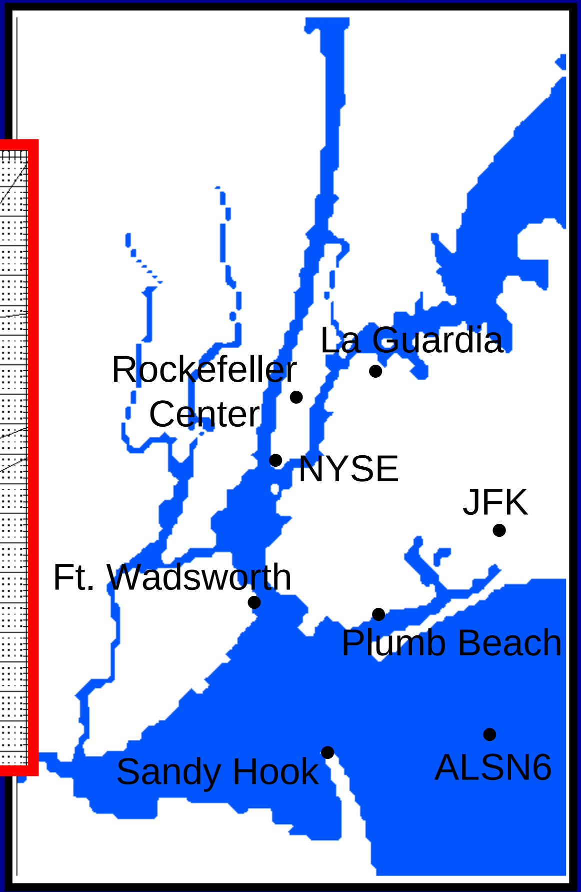
- Common horizontal grid configuration among modeling groups (NRL, LLNL, SUNY-Stony Brook, SJSU)



Nest 1 (36 km)



Nest 4 (1.33 km)

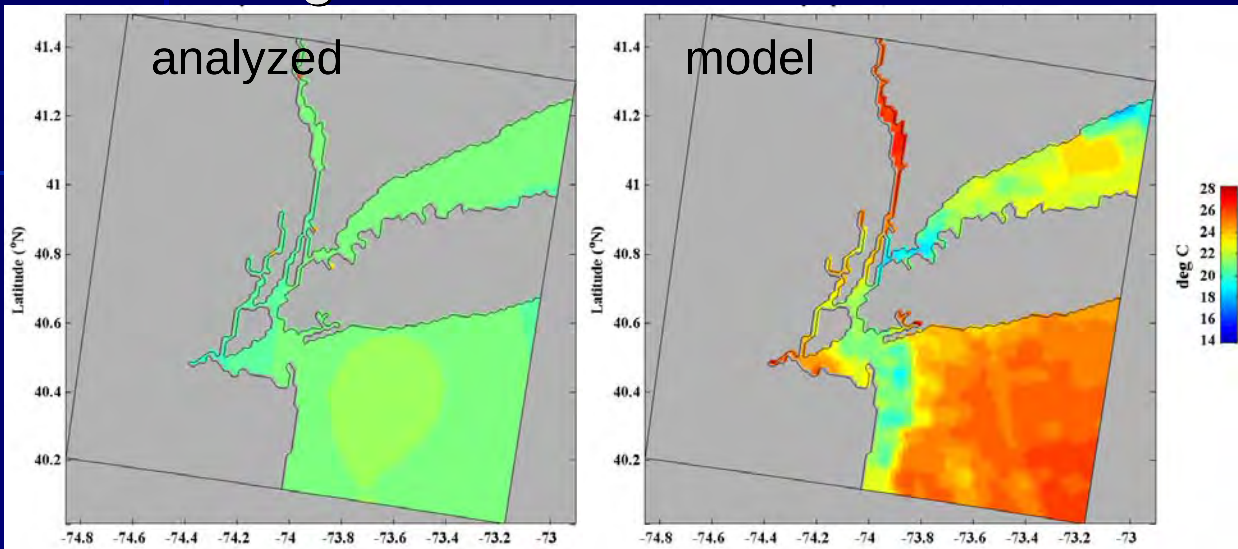


Nest 5 (0.444 km)

(5 nests: 36 km to 0.444 km)

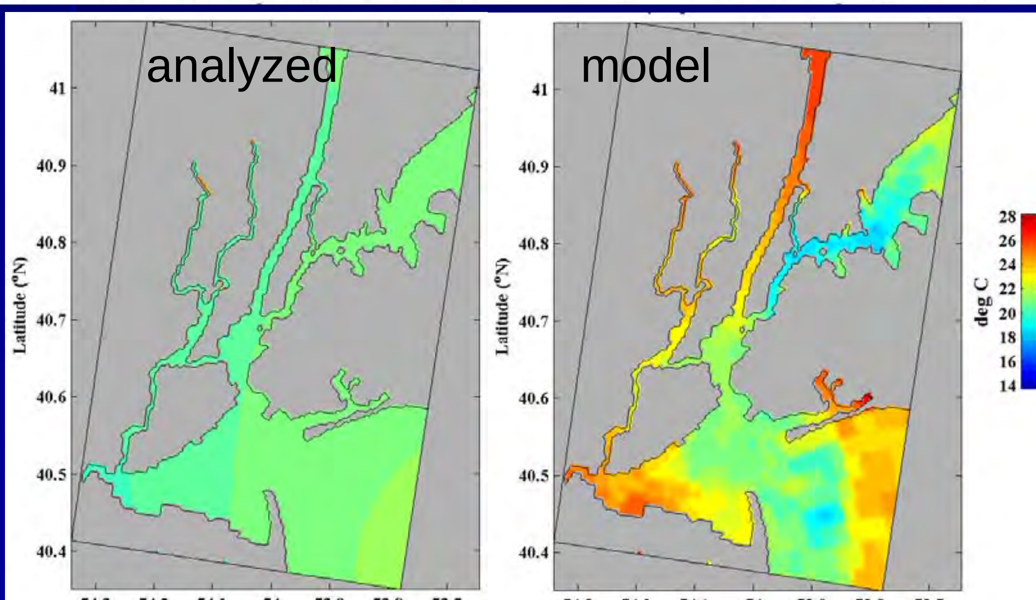
NYC Mesoscale Modeling

Realistic High-Resolution SST's

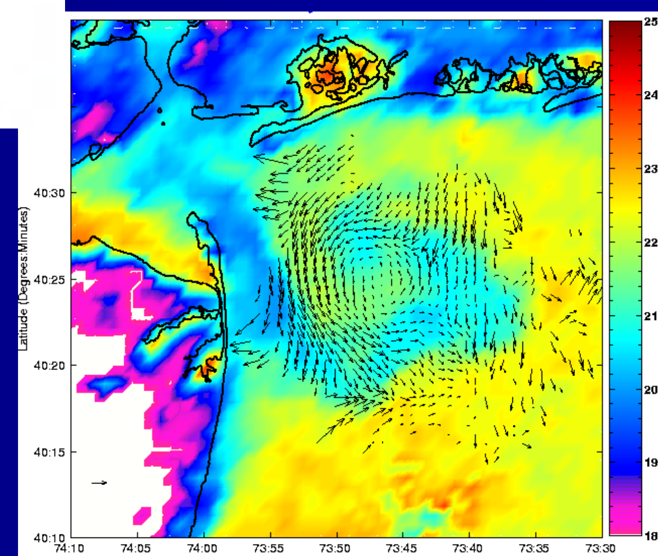


COAMPS nest 4 (1.33 km)

00 UTC 5 July 2004

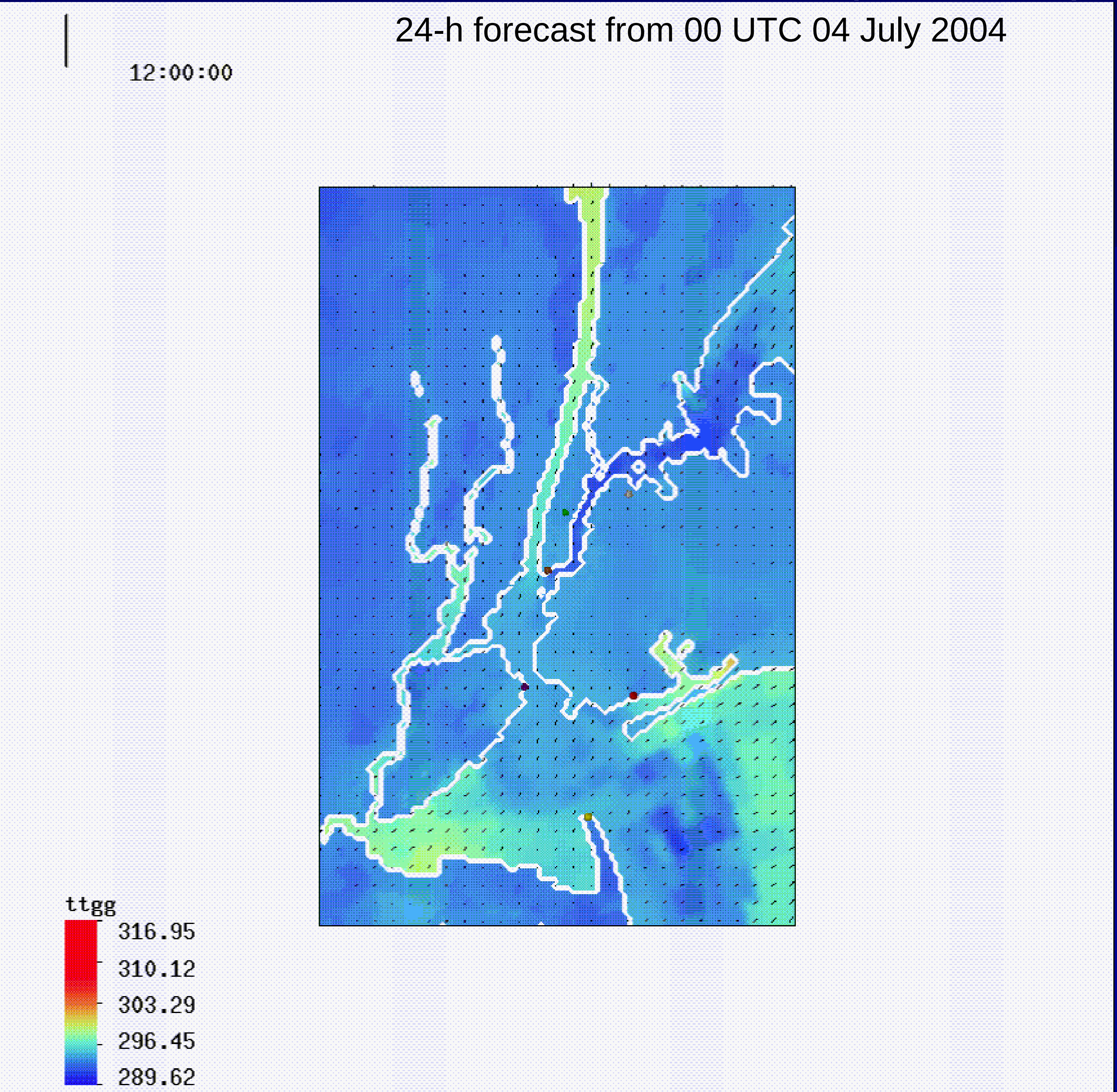


COAMPS® nest 5 (0.444 km)



Observed SST

COAMPS® NYC Nest 5 (0.444 km)



Output shown every 15 min 12 UTC 4 July to 00 UTC 5 July

Continuous 2-m release of 200 kg s^{-1} starting at 12 UTC 4 July 2004 at 6 sites

Concentration (1 mg m^{-3} isosurface)

Surface temperature (color shading, K)

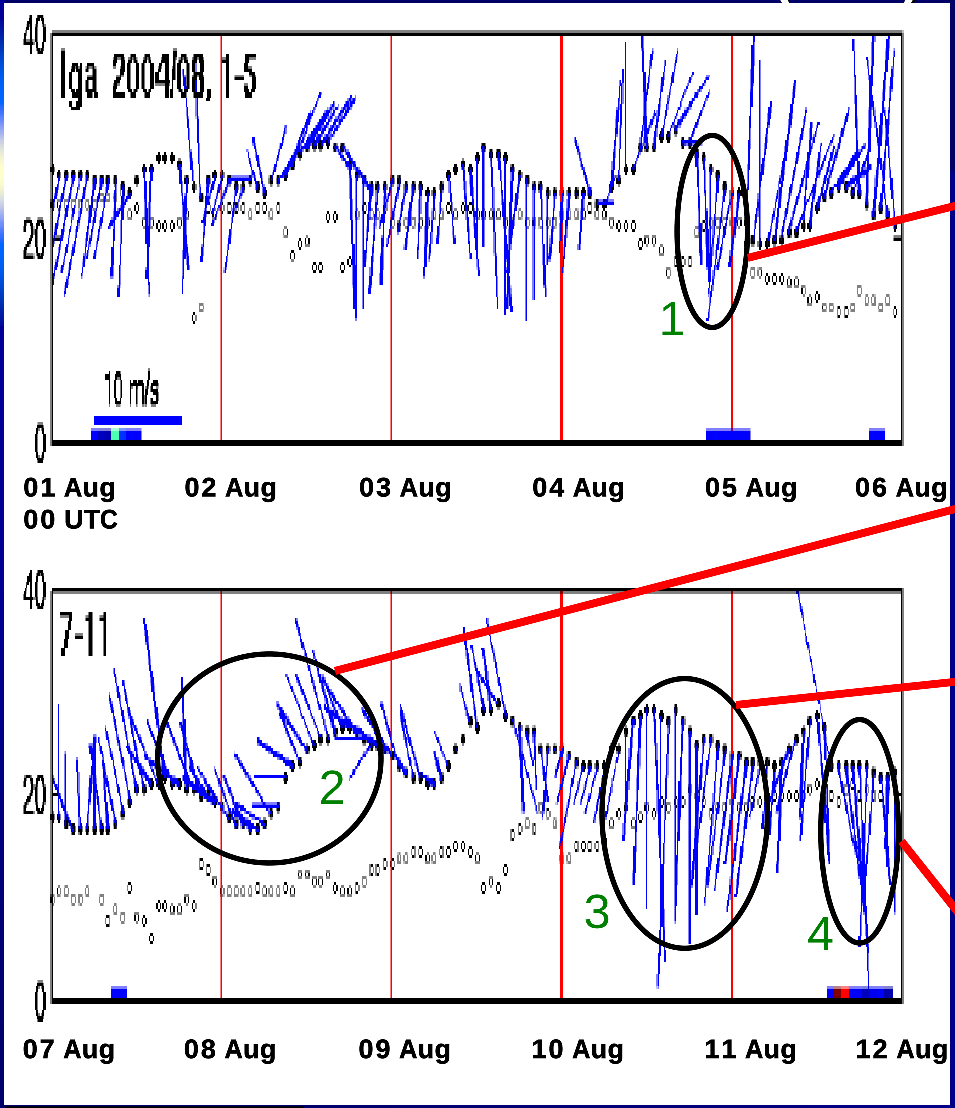
model SST (varied hourly)

10-m wind arrows

UCP

NYC Mesoscale Modeling

LaGuardia (LGA) 1-12 Aug 2004



<u>Classic sea breeze</u>
Northerly to southerly wind shift
Temperature decrease
Dew point increase

<u>Sea breeze-NW wind interaction</u>

<u>Southerly synoptic flow with sea breeze enhancement</u>

<u>Sea breeze with afternoon and evening precipitation</u>

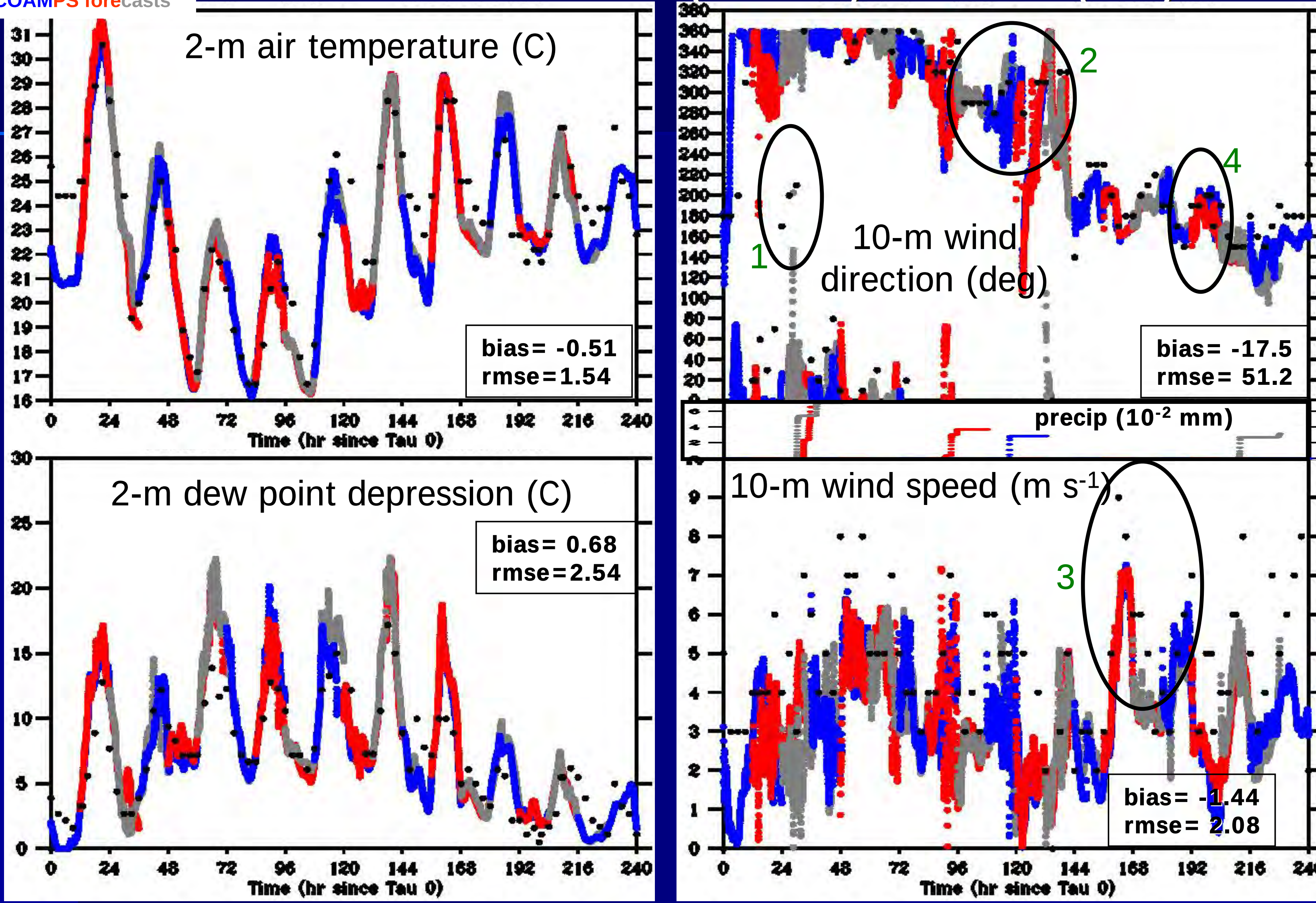
Courtesy of Michael Reynolds, BNL

NYC Mesoscale Modeling

Hourly model SST
UCP

Observations
COAMPS forecasts

COAMPS® NYC Nest 5 (0.444 km): LaGuardia (LGA)

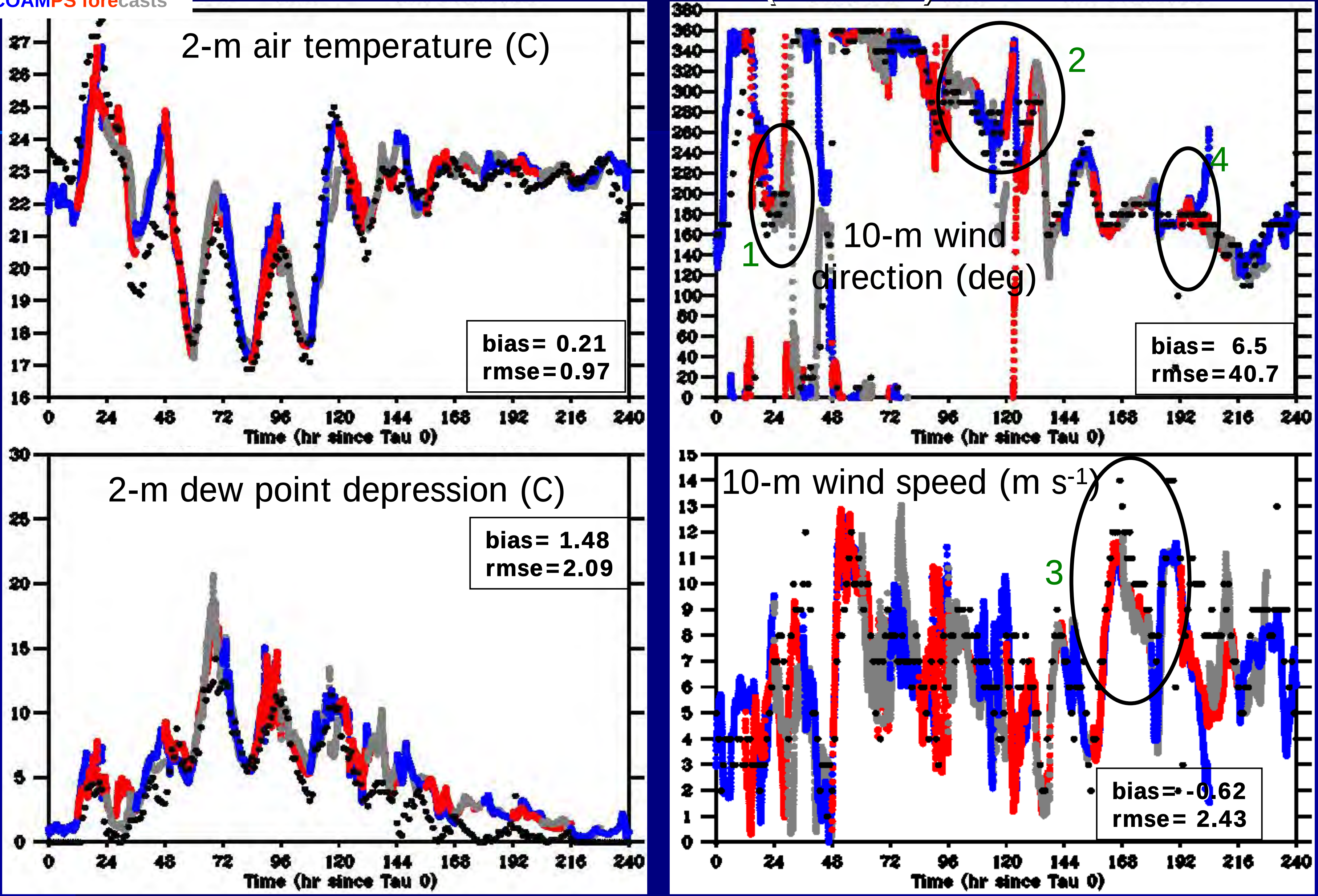


NYC Mesoscale Modeling

Hourly model SST
UCP

Observations
COAMPS forecasts

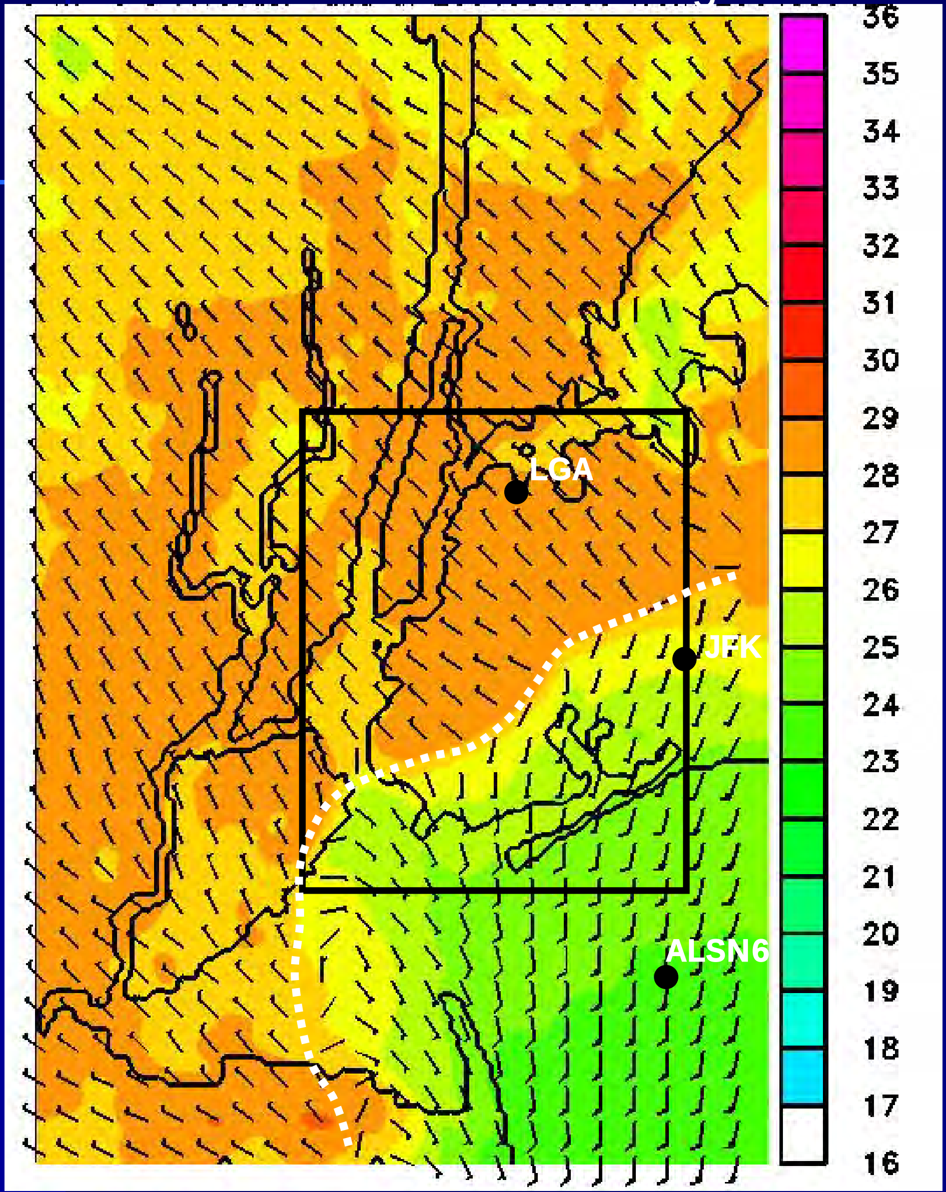
COAMPS® NYC Nest 5 (0.444 km): ALSN6



NYC Mesoscale Modeling

12-h forecast valid 00 UTC 5 Aug 2004

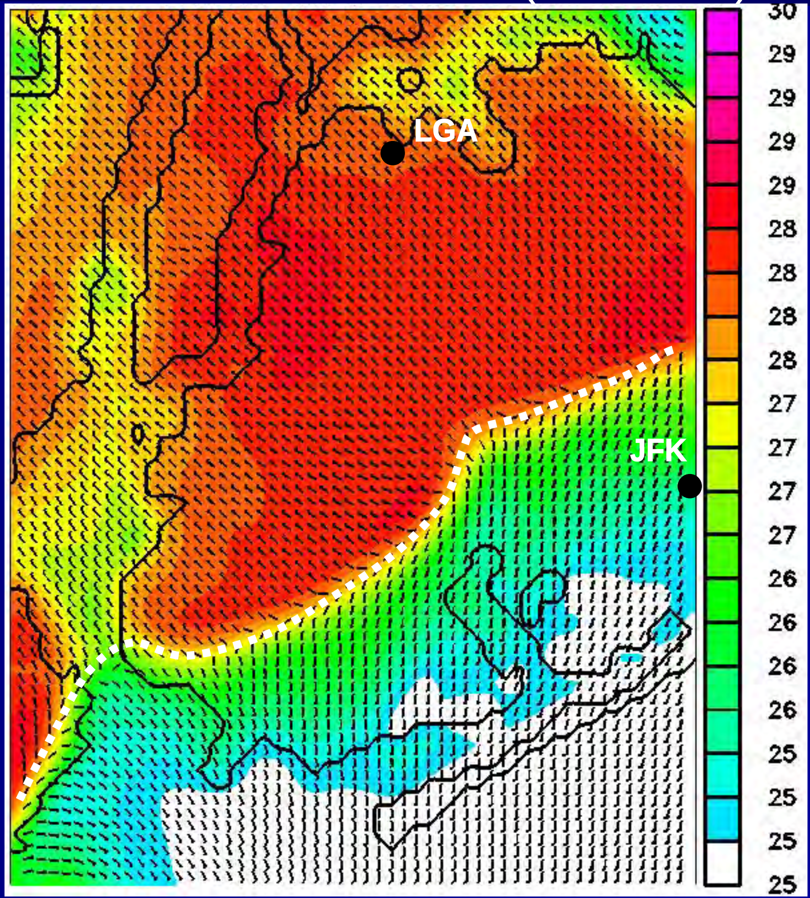
10-m winds; 2-m air temperature (C)



Winds every 5th grid point

Hourly
NYHOPS
UCP

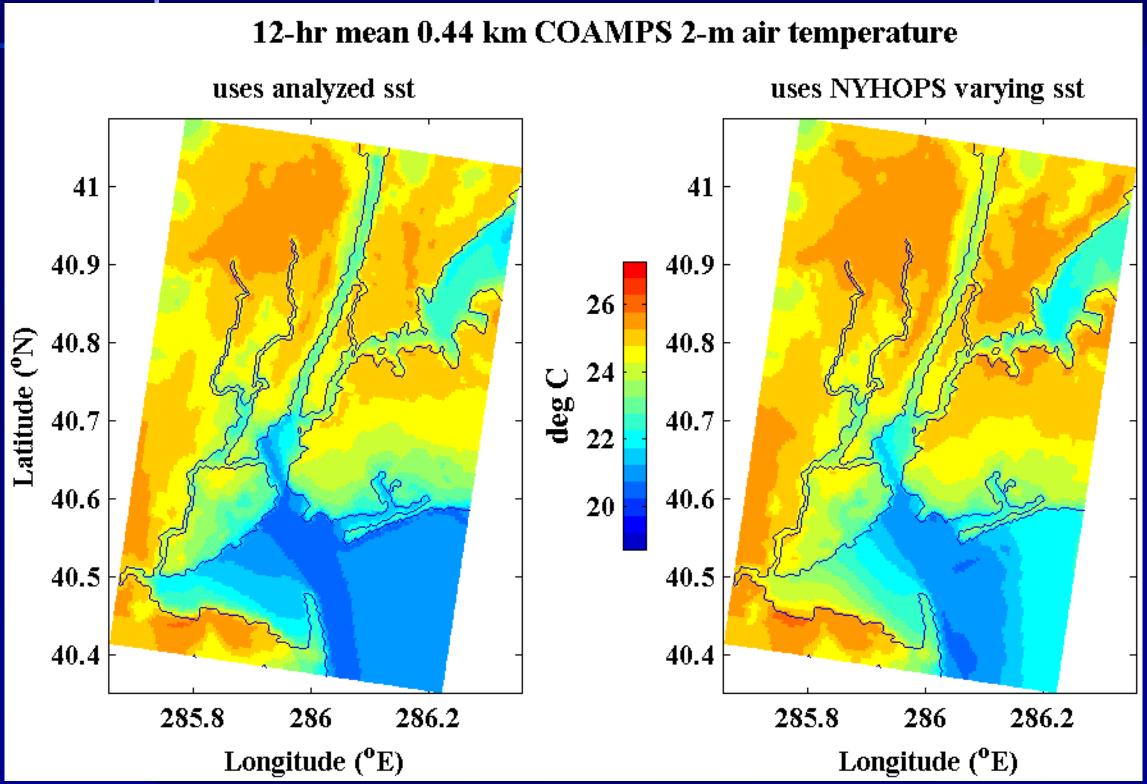
COAMPS® NYC Nest 5 (0.444 km)

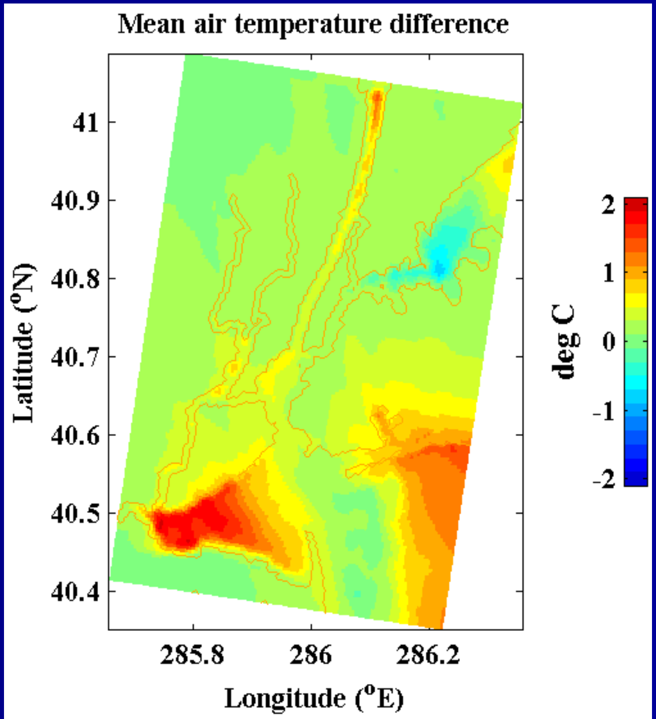


Subset: Winds every grid point

COAMPS® NYC

Hourly model SST versus analyzed SST



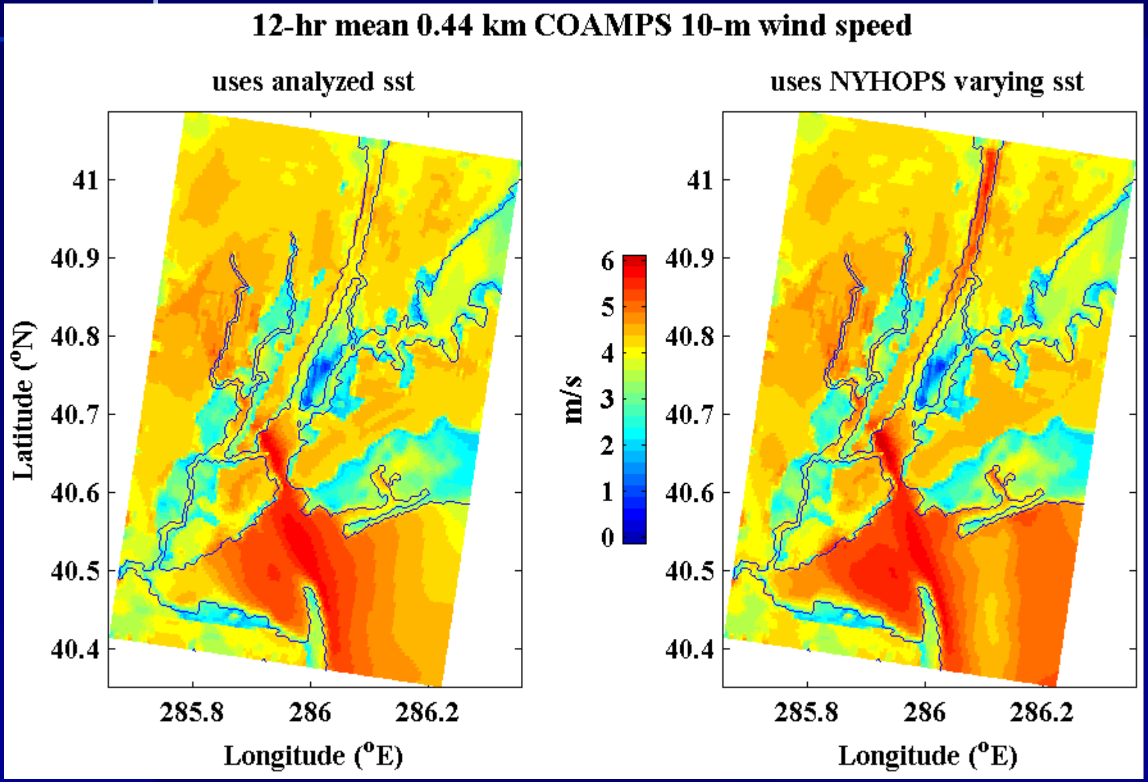


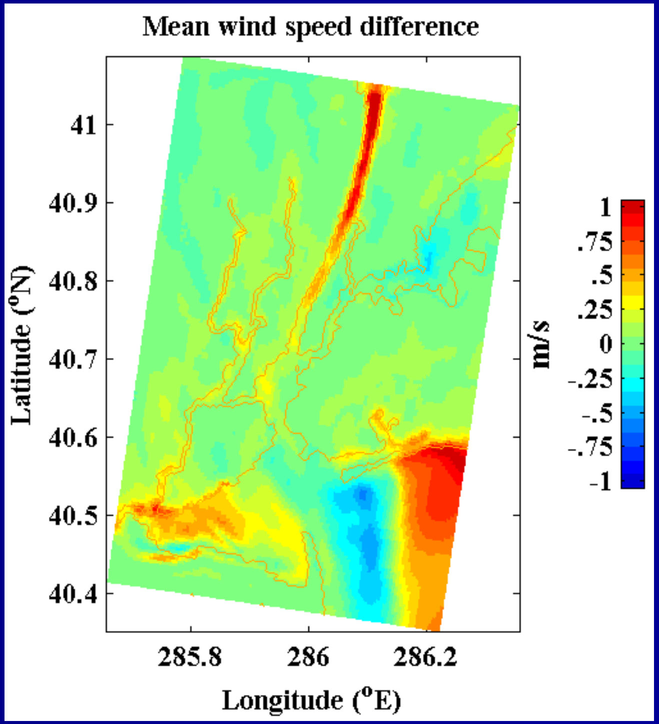
24-h forecast from 2004070400

12-h daytime period from 2004070412 to 2004070500

COAMPS® NYC

Hourly model SST versus analyzed SST

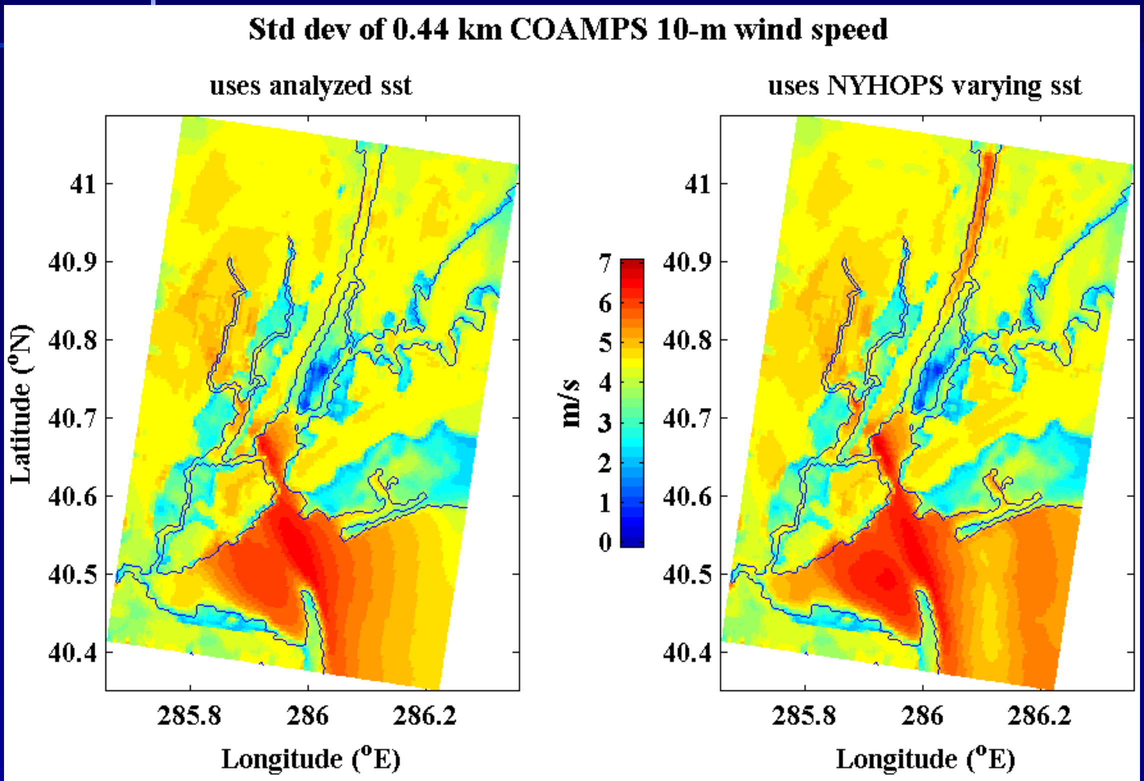


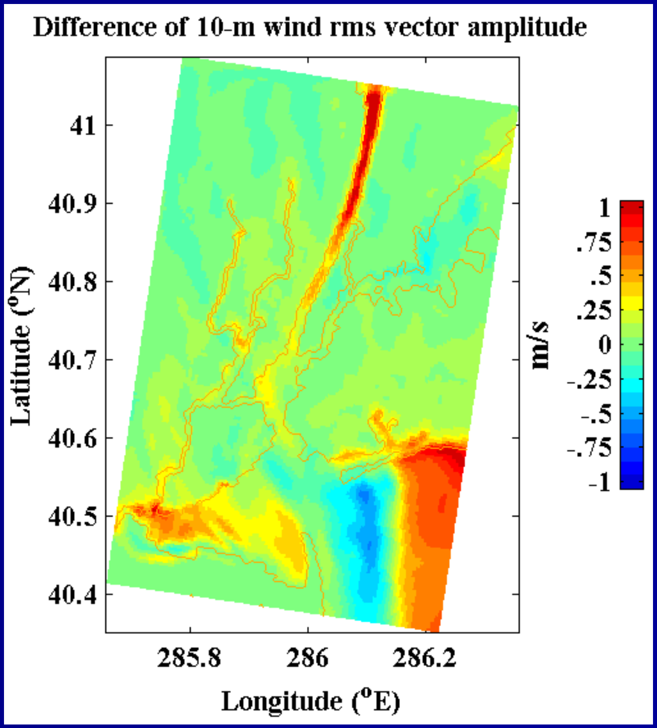


24-h forecast from 2004070400
12-h daytime period from 2004070412 to 2004070500

COAMPS® NYC

Hourly model SST versus analyzed SST





24-h forecast from 2004070400

12-h daytime period from 2004070412 to 2004070500

Two-Way Air-Sea Coupling: Studies of the Adriatic

Julie Pullen and James Doyle

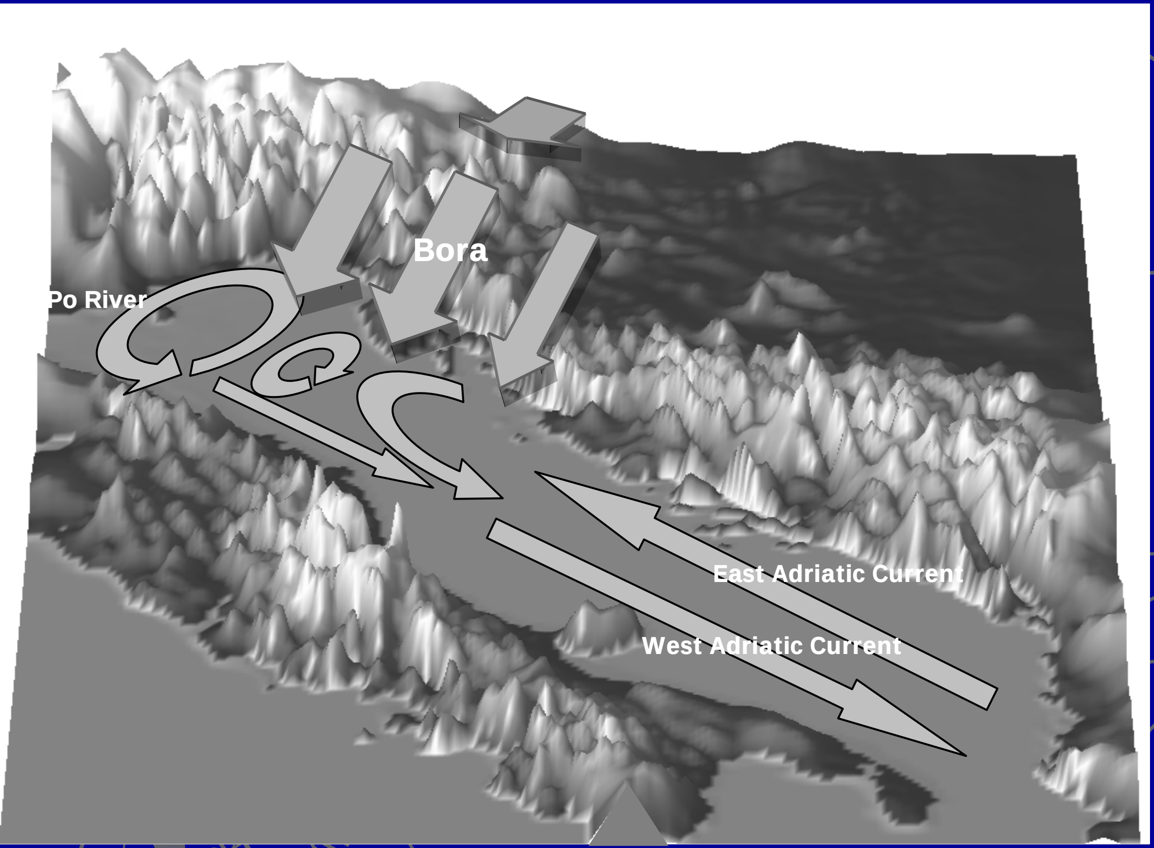
Naval Research Laboratory–Monterey

Richard Signell

NATO Undersea Research Center, ITALY

(in press, MWR)

Adriatic Circulation Patterns

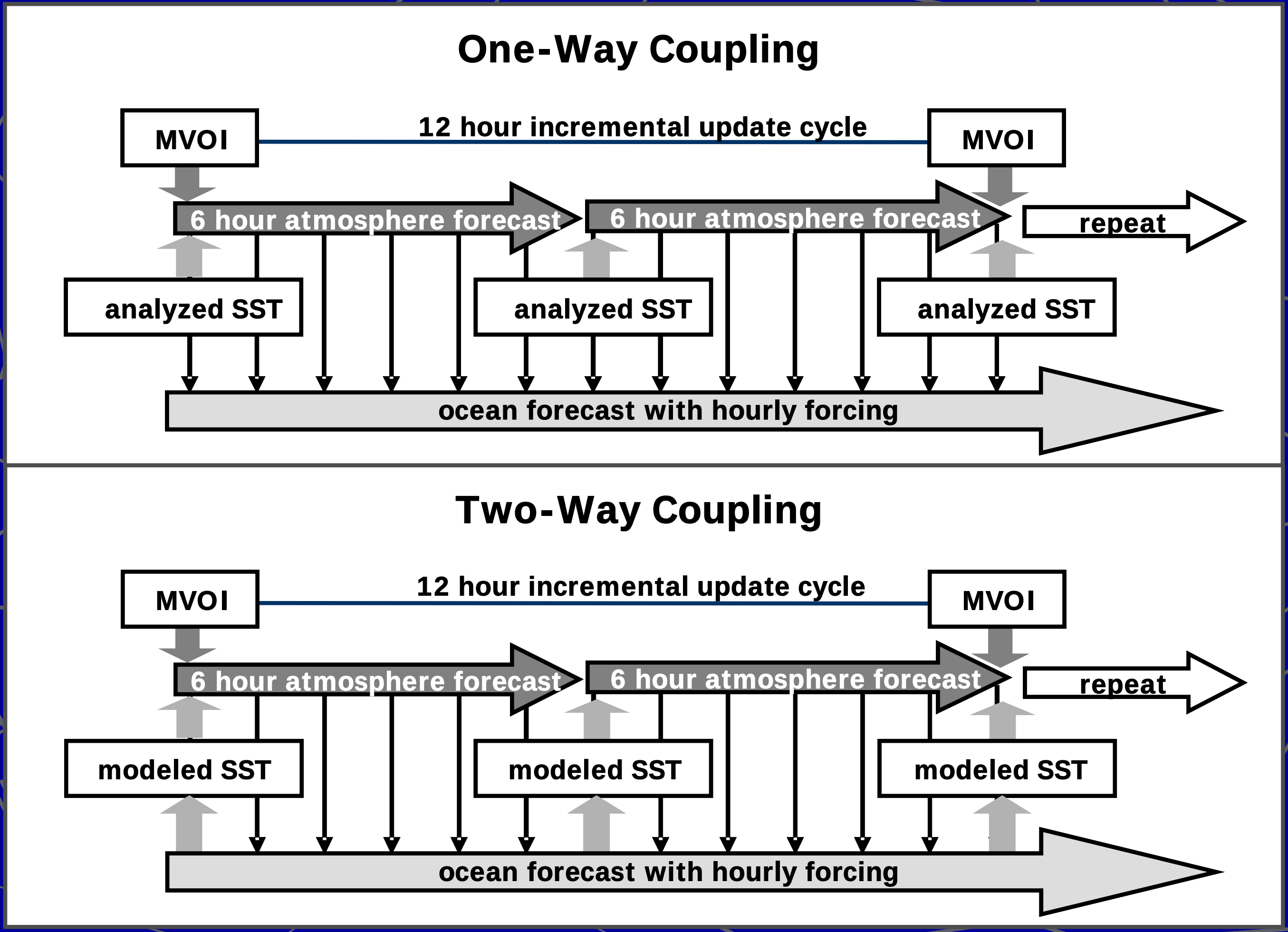


Pullen et al. (JGR-oceans, 2003):

- documented the bora-induced generic double gyre in the ocean
- evaluated one-way coupled model using ocean and atmosphere velocity observations
- quantified the importance of high-resolution atmospheric fields for forcing ocean models

Model Set-up

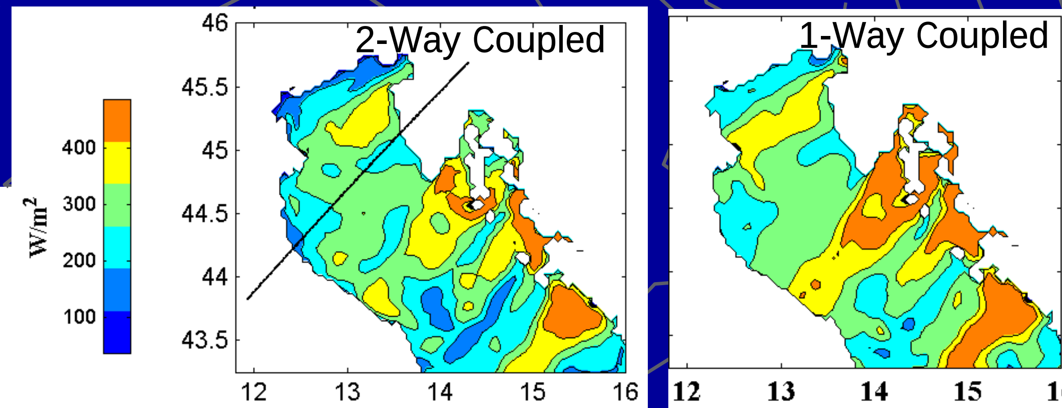
- 2-km resolution ocean model (NCOM)
- 4-km resolution atmosphere model system (COAMPS)



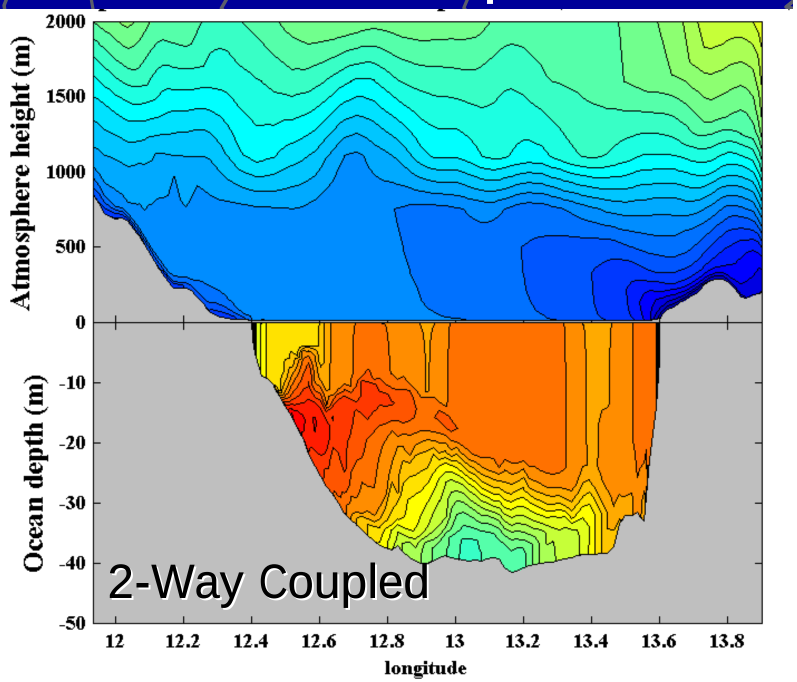
Boundary Layer & Surface Fluxes During a Bora Event

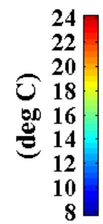
(29 September 2002 6Z)

Latent Heat Flux

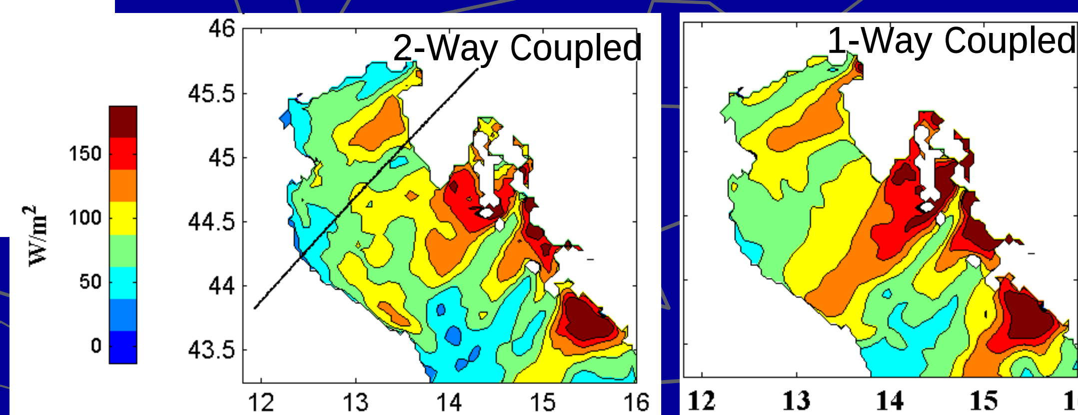


Potential Temperature



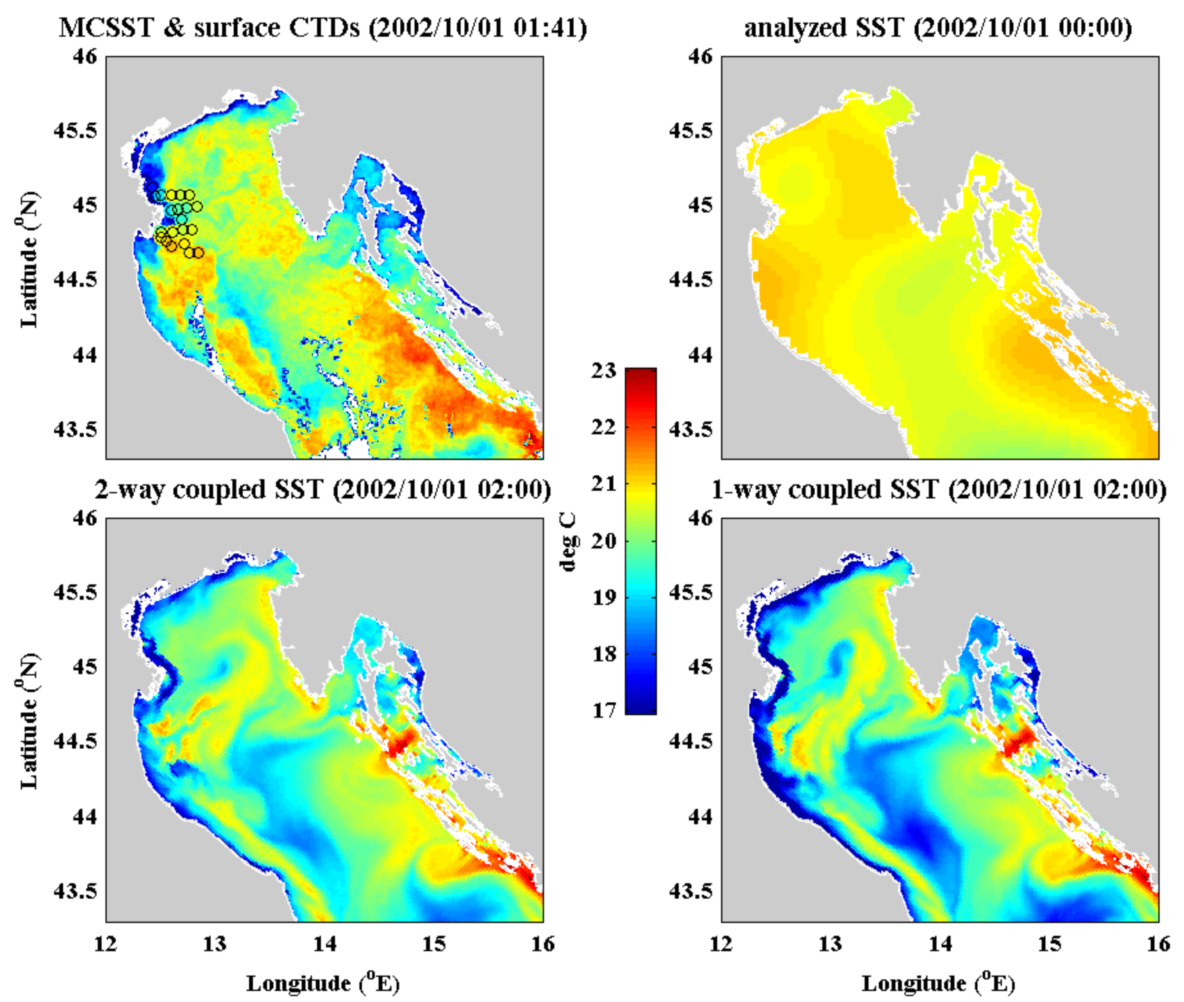


Sensible Heat Flux



Post-Bora SST Evaluation

(1 October 2002)



Basic Statistics

(in deg C)	*N*	*mean*	*Standard dev*
observed	39,217	20.06	1.19
analysis	37,214	20.80	0.21
1-way coupled	37,319	19.48	1.26
2-way coupled	37,319	19.81	0.88

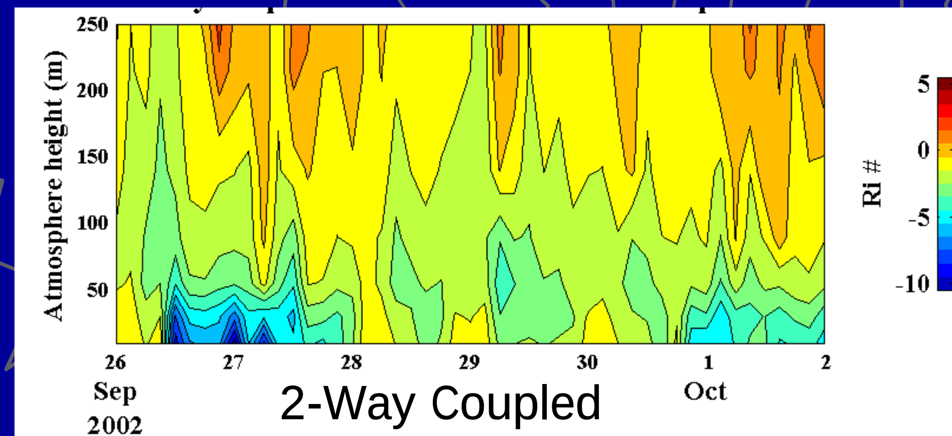
Comparison Statistics

	N	*MB*	*RMSE*	*CC*
analysis	35,977	0.59	1.16	0.23
1-way coupled	36,295	-0.69	1.22	0.60
2-way coupled	36,295	**-0.38**	**0.97**	0.57

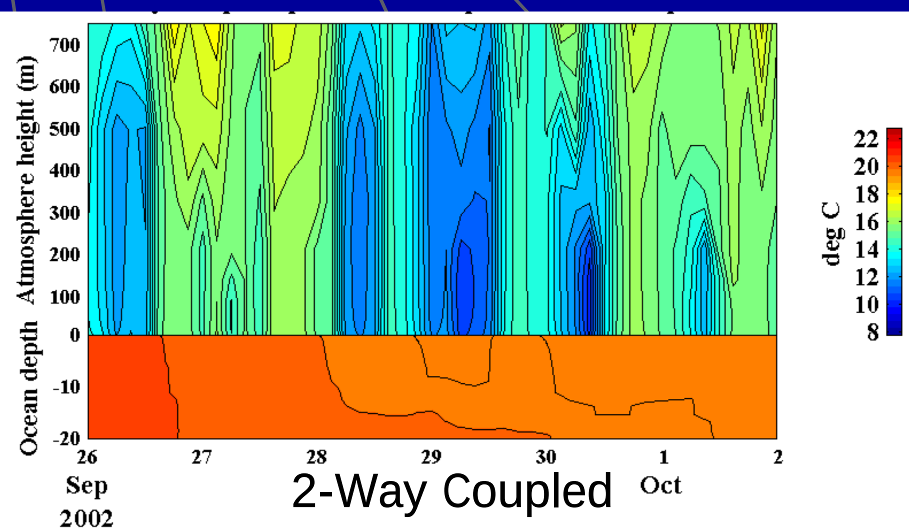
Boundary Layer Evolution During a Bora Event

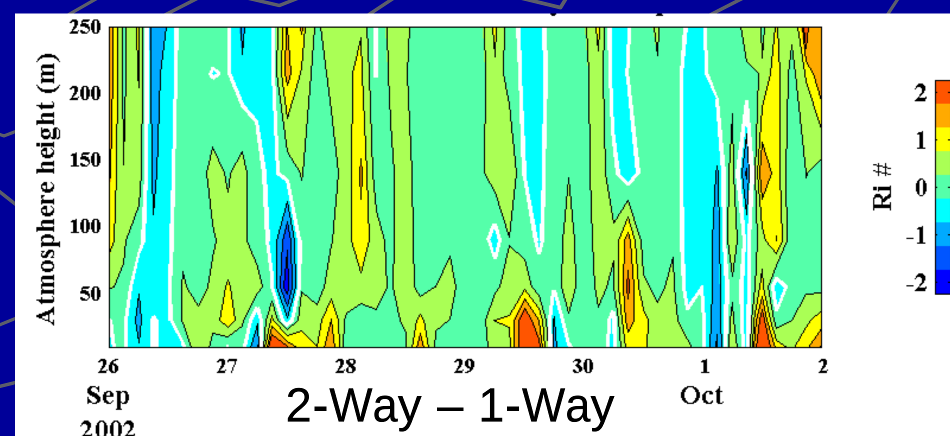
Acqua Alta (over-water site near Venice)

Richardson Number



Potential Temperature

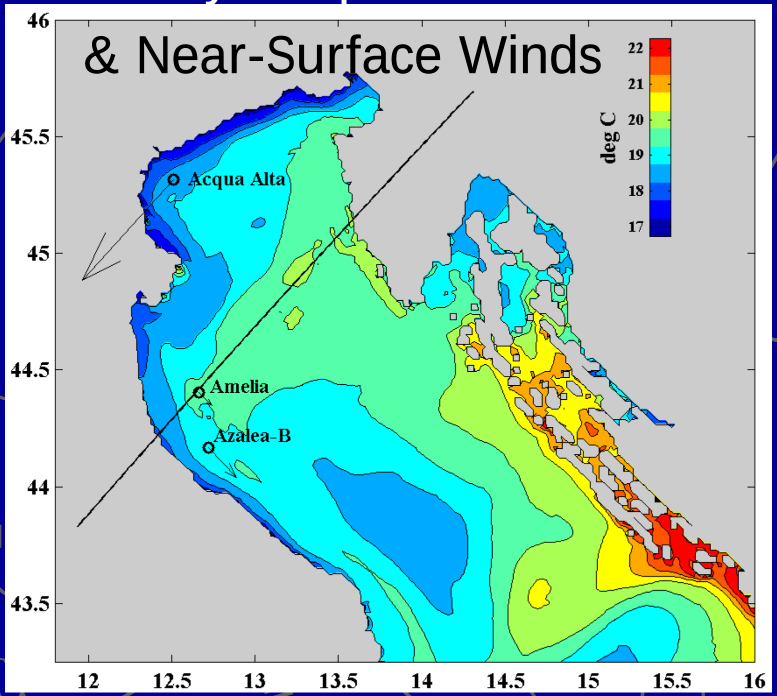




Wind & Temperature Evaluation

(23 September – 23 October 2002)

2-Way Coupled Mean SST

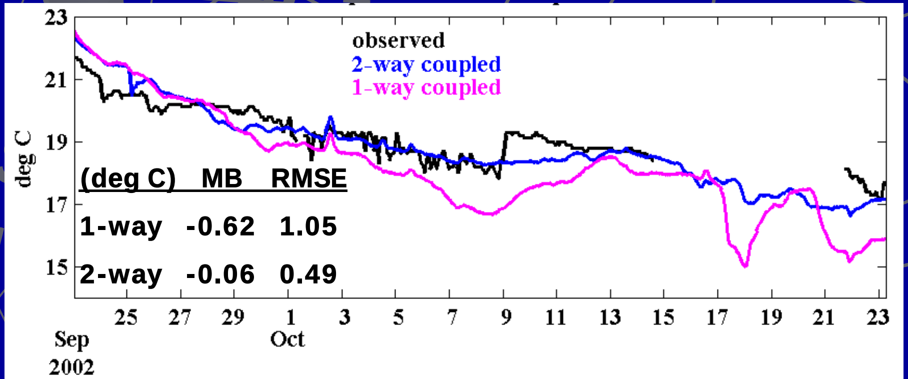


Wind Speed Statistics

(in m/s)	*N*	*mean*	*Standard dev*
Acqua Alta			
observed	726	5.36	3.76
1-way coupled	726	5.59	3.27
2-way coupled	726	5.35	3.13
Amelia			
observed	722	4.76	3.21
1-way coupled	722	5.44	2.93
2-way coupled	722	5.32	2.85
Azalea-B			
observed	655	5.05	2.94
1-way coupled	655	5.74	2.76
2-way coupled	655	5.51	2.67

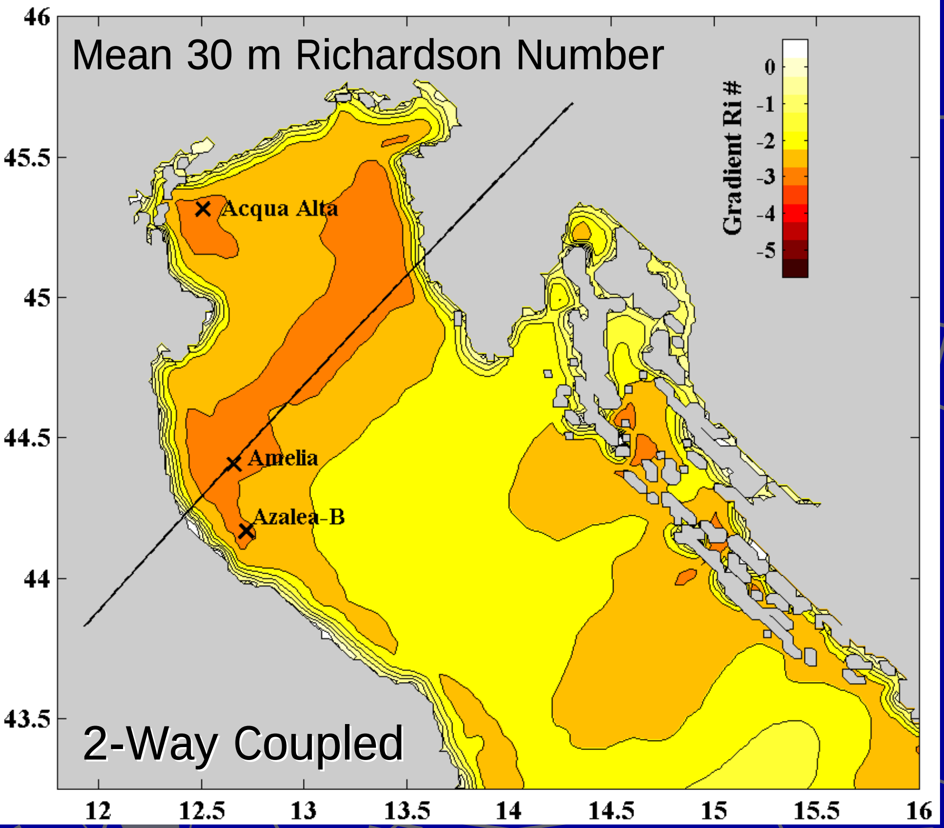
	MB	*RMSE*	*CC*
Acqua Alta			
1-way coupled	-0.23	2.81	0.69
2-way coupled	**0.01**	2.82	0.68
Amelia			
1-way coupled	-0.67	3.20	0.48
2-way coupled	**-0.56**	3.12	0.49
Azalea-B			
1-way coupled	-0.69	2.97	0.49
2-way coupled	**-0.46**	2.98	0.45

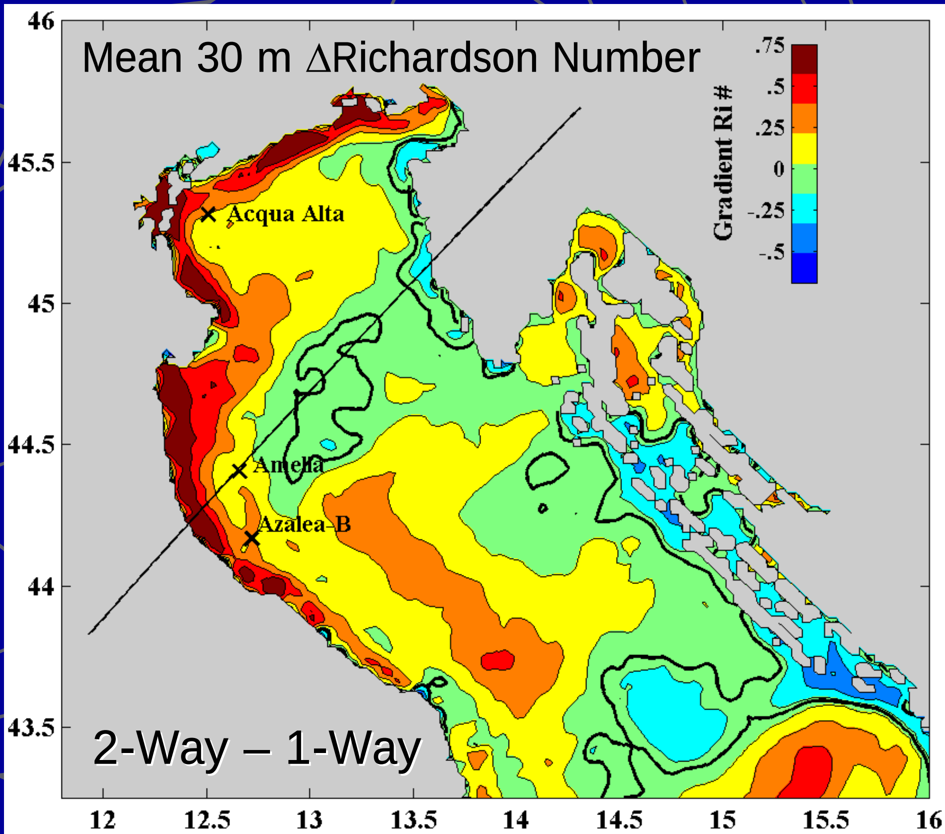
Acqua Alta Ocean Temperature



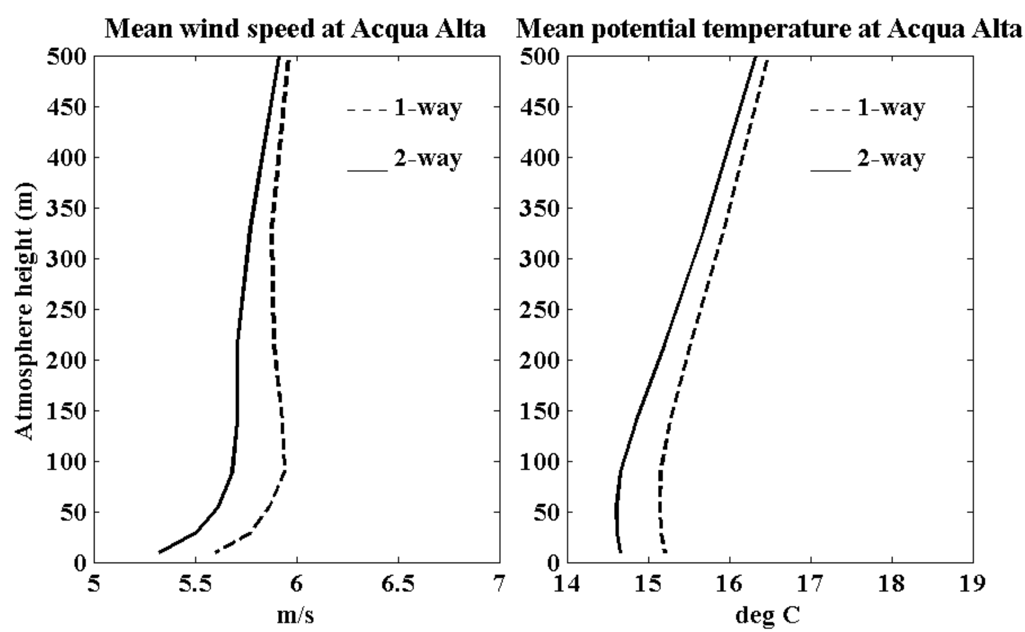
Atmospheric Stability Difference

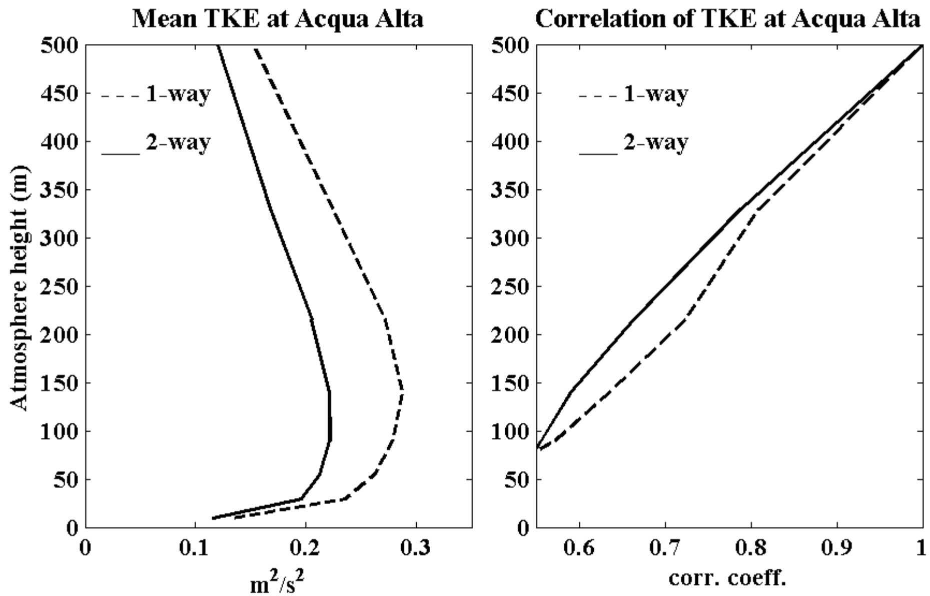
(23 September – 23 October 2002)





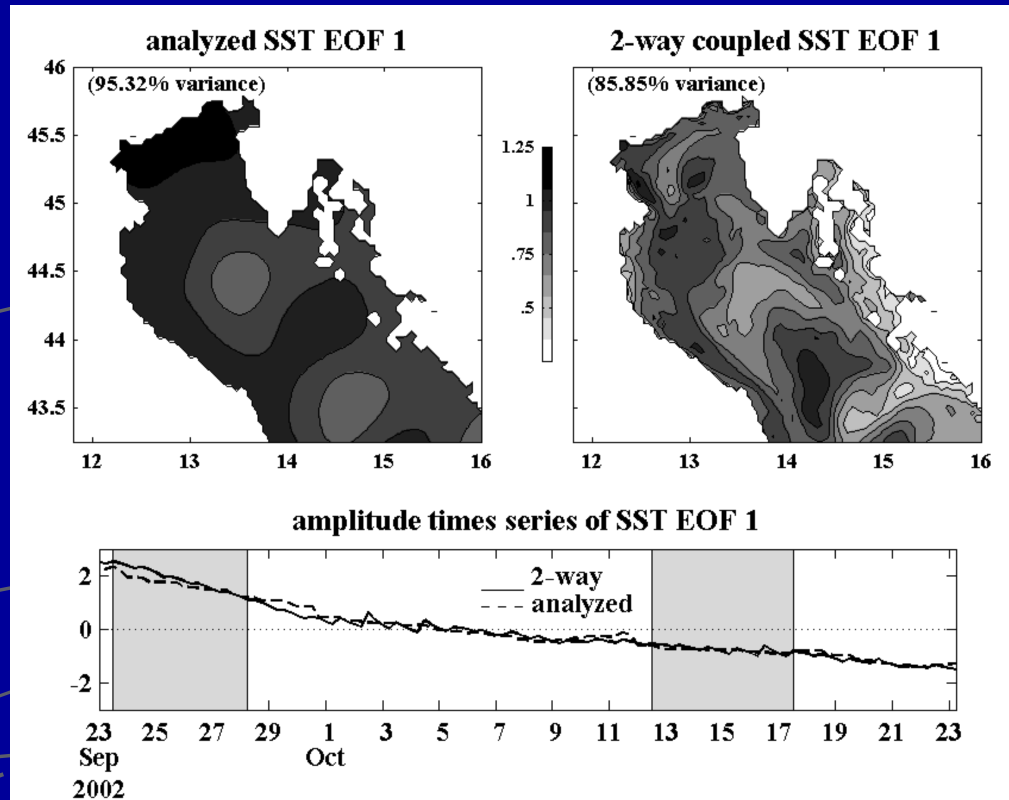
Point Statistics

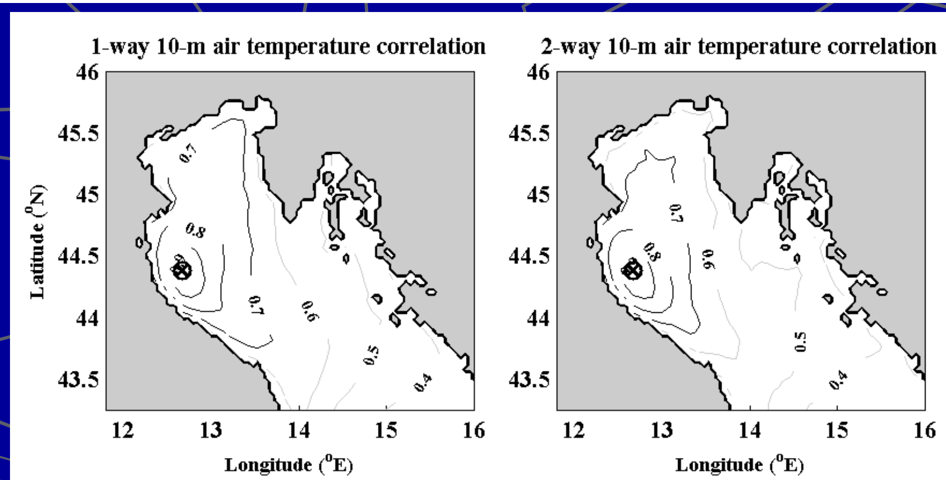




- 2-way TKE is reduced by 20% in the lower ABL
- 2-way TKE is less vertically coherent

EOFs & Correlations



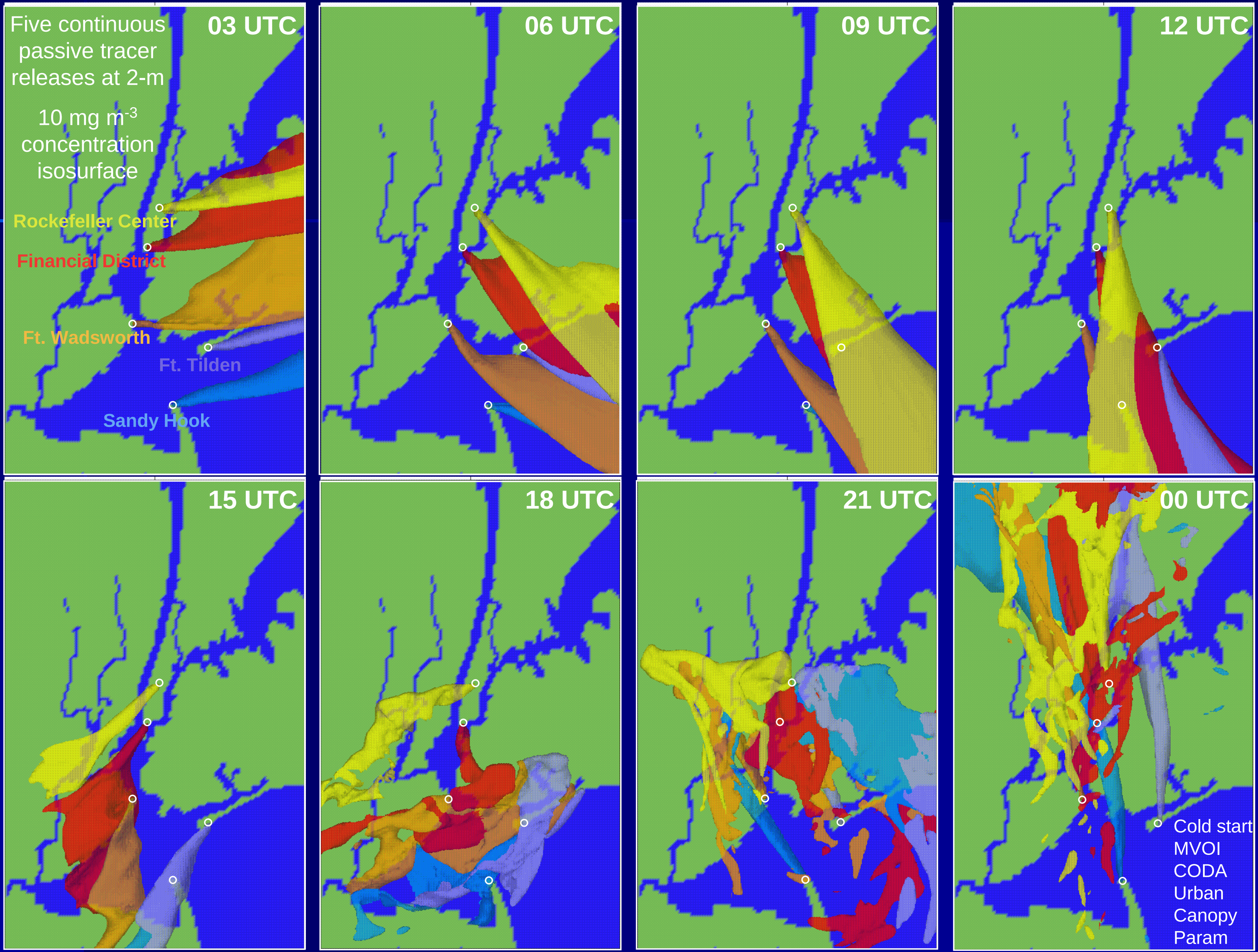


Summary

- Using satellite MCSST data and in situ ocean temperature observations to evaluate model-derived SST, the 2-way coupled simulation had lower mean bias and RMSE error compared to the 1-way coupled simulation.
- At gas platforms in the northern Adriatic, the 2-way coupled model produced lower mean wind speeds that accorded better with measurements than did the values from the 1-way coupled model.
- Cooler SSTs represented in the 2-way coupled simulation stabilize the atmosphere relative to the 1-way coupled simulation, leading to reduced (more realistic) wind speeds in the 2-way coupled simulation.
- 2-way coupling impacts the correlation structure of atmospheric variables such as TKE and air temperature.

Back-Up Slides

COAMPS® Nest 5 (0.44-km) Sea-breeze simulation: 18 April 2005 (24-h fcst from 00 UTC)



Exploring Optimization Methodologies for Systematic Identification of Optimal Defense Measures for Mitigating CB Attacks

Roshan Rammohan, Molly McCuskey
Mahmoud Reda Taha, Tim Ross and Frank Gilfeather
University of New Mexico

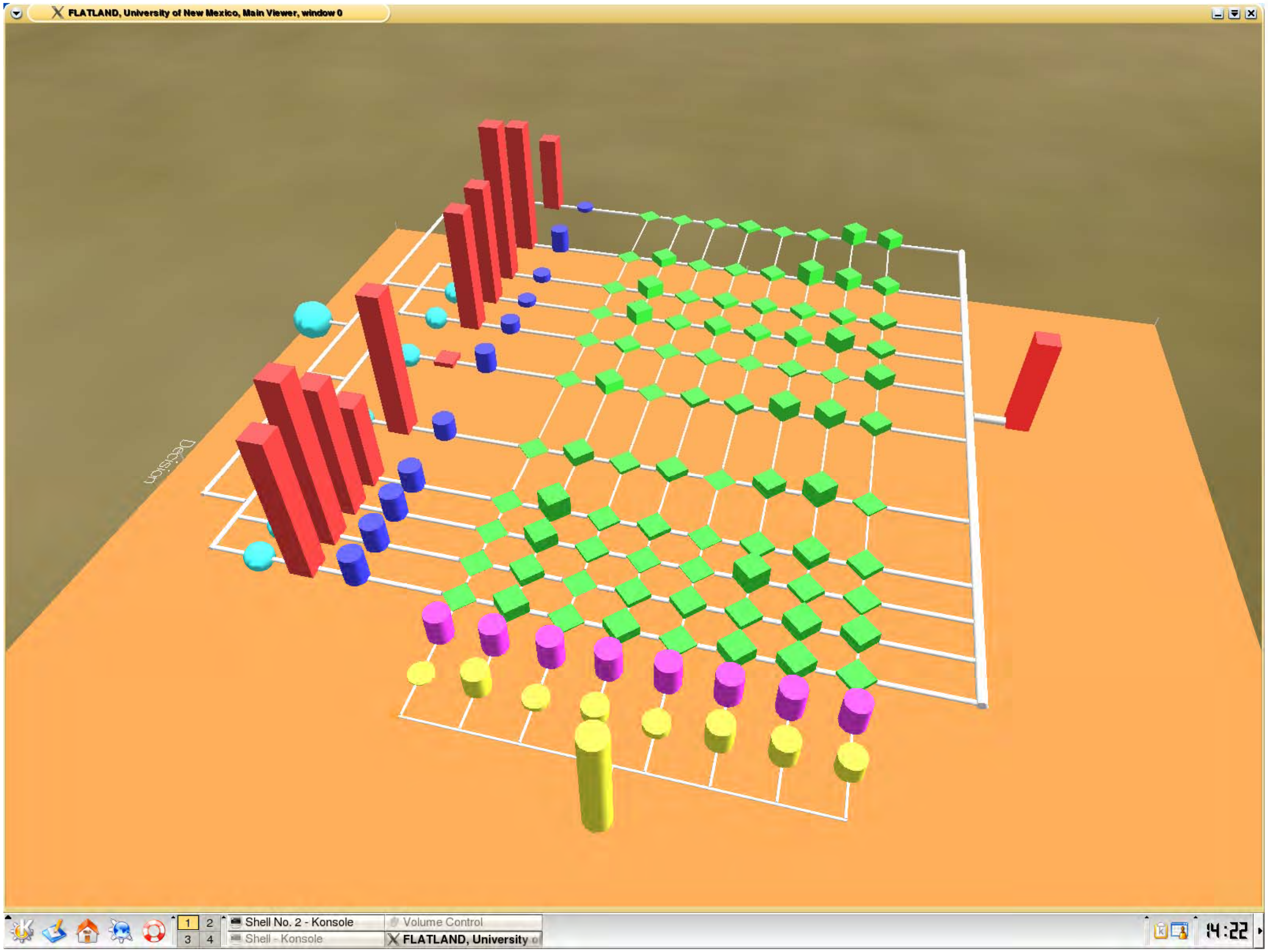
Ram Prasad

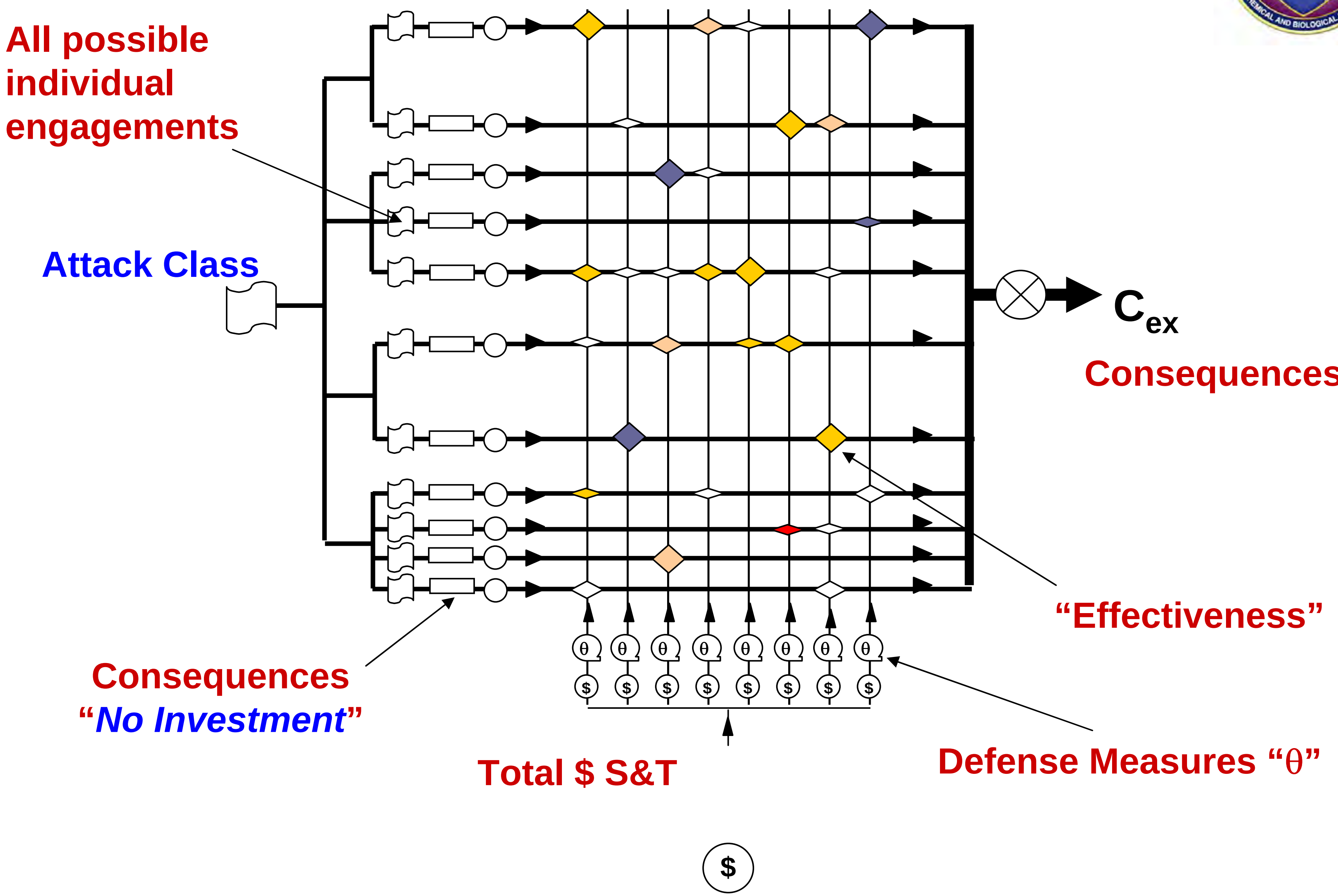
New Mexico State University

Outline

- The general architecture
- How the analytic tool relates to the architecture
- Optimization mode: the problem
- Optimization Techniques With Example Application
- Conclusions

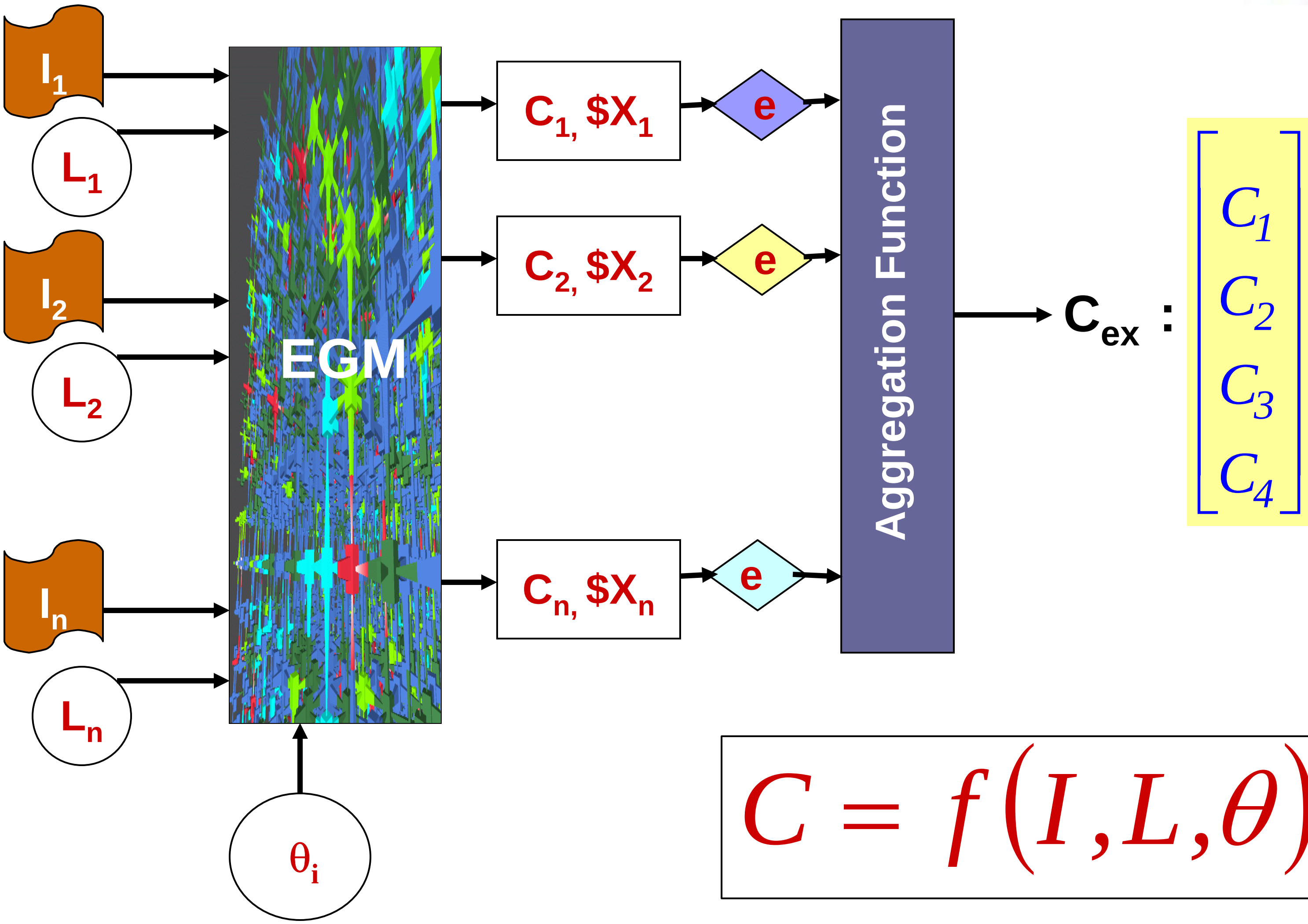
The General architecture





All possible individual engagements
Attack Class
C_{ex}
Consequences
"Effectiveness"
Consequences
"*No Investment*"
Total $ S&T
Defense Measures "θ"
θ
$

The Analytic Tool "Exploration Mode"



$$C = f\left(I, L, \theta\right)$$

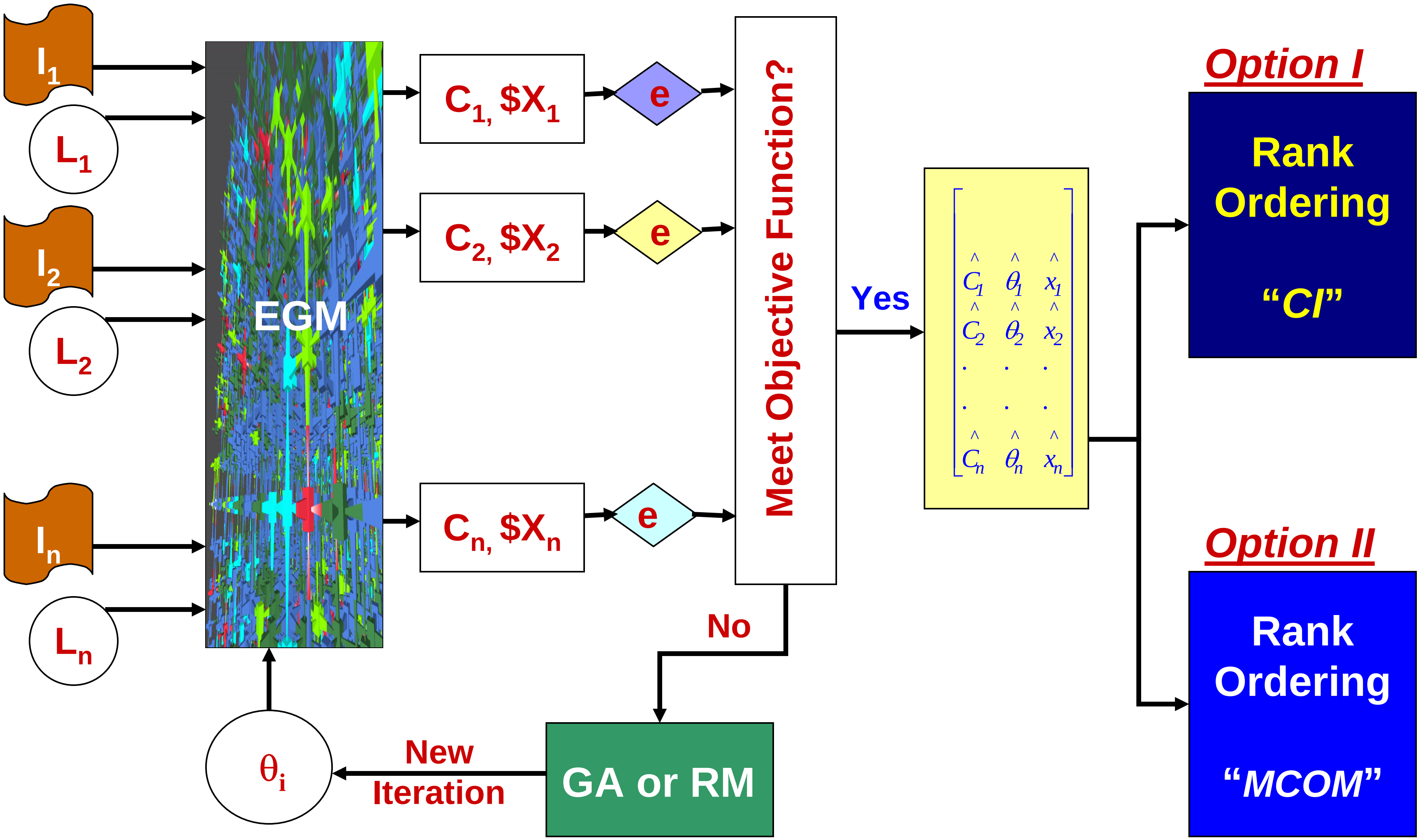
EGM: Engagement Generation Module

The Analytic Tool: “Optimization Mode”

❑ Problem Statement

What is the ***optimal way*** to distribute ***$X*** to ***N (mitigating variables) defense measures*** in order to reduce damage ***(consequences) of a CB attack***?

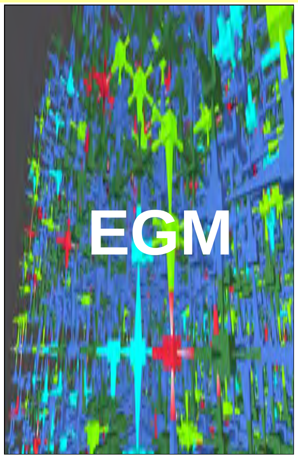
The Analytic Tool: “Optimization Mode”



Analytic Toolbox

- Three main components

Component I:



Component II:

Optimization Module

Component III:

Rank Ordering Module

Focus of this talk

Component II: Optimization Module

Mathematically, we can describe ***the relation*** as

$$C = f(x, \theta)$$

x: all input parameters

θ: all defense measures

C: all consequences

The ***optimization module*** targets finding the optimal ***defense measures*** ($\hat{\theta}$) and their associated ***cost*** ($\$\hat{X}$) that achieves a predefined set of consequences ($\boldsymbol{C_{ex}}$) considering all possible attacking engagementss.

If we have a bimodal surface

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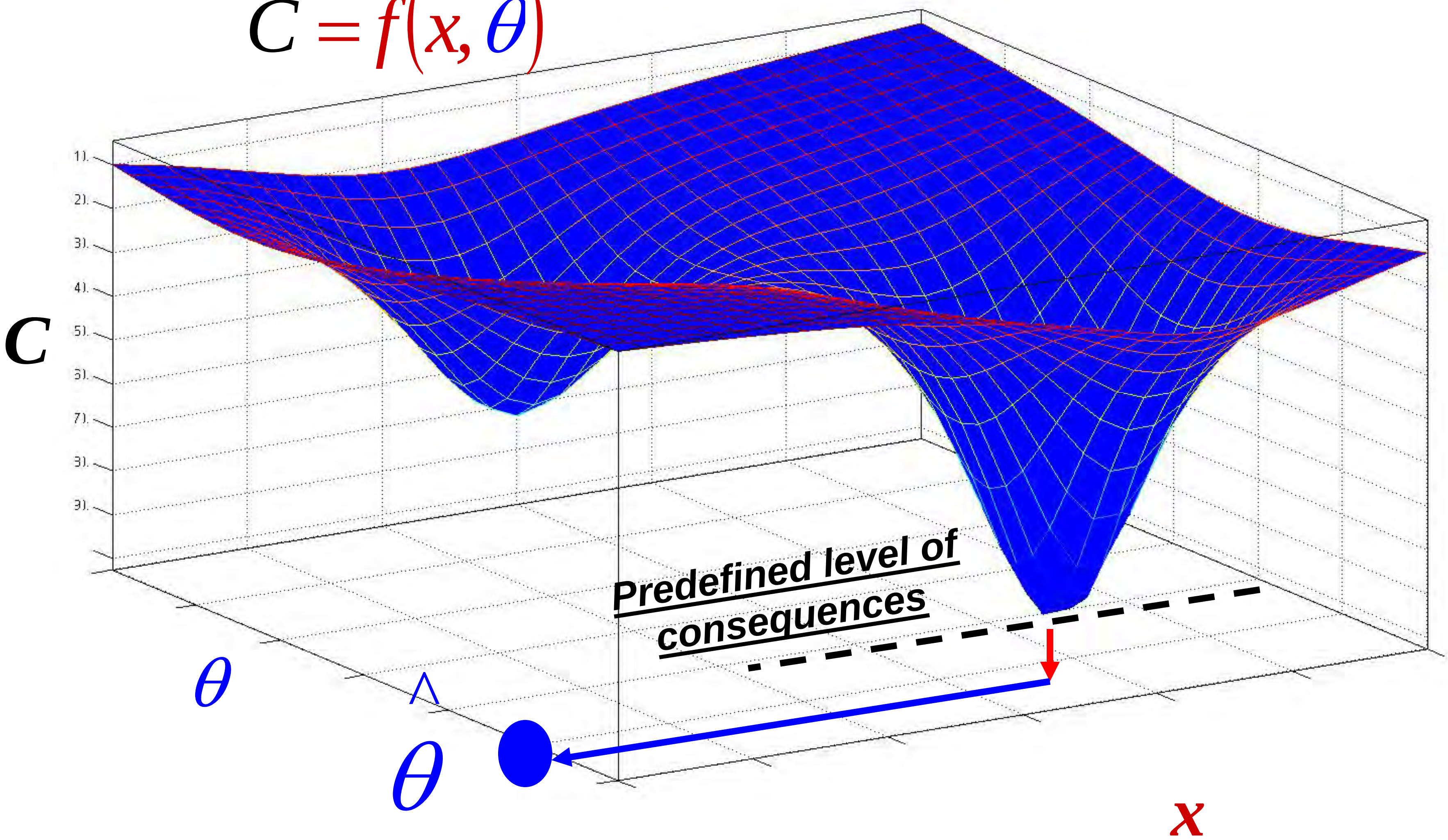


The challenge is that the ***function*** that can describe the ***relationship*** between ***CB attack parameters*** (attack target, attacker, etc), the defense measures and the ***attack consequences*** is ***unknown***

When ***the function is unknown***, a well known technique ***is to minimize the error*** (squared error) between the ***desired output*** and the ***model's output***.

predefined consequences

EGM output

$$E(\theta)=\sum_{k=1}^{n}\left(C_{desired}-f\left(x,\theta\right)\right)^{2}$$

Objective function

Two optimization approaches can be used here

<u>Stochastic approximation</u>

-Robbins Munro Optimization (RM)

<u>Search Methods (Derivative free optimization)</u>

- Genetic Algorithms (GA)

- Simulated Annealing (SA)

- The first technique is ***Robbins Munro (RM)*** as a technique to perform ***stochastic optimization***.

-This method is designed to find the roots of ***an unknown function $f(\theta)$*** when the value of ***$f(\theta)$*** can be provided for any specified θ

- ***By replacing $f(\theta)$ by its derivative $f(\theta)'$***, the optimal defense measures $\hat{\theta}$ to achieve ***pre-specified consequences (C_0)***can be found.

Capabilities of RM

-Due to the use of a numerical gradient in determining the rate of convergence, this method has ***high ability to adapt to local rates*** of change of the function along its many parameters.

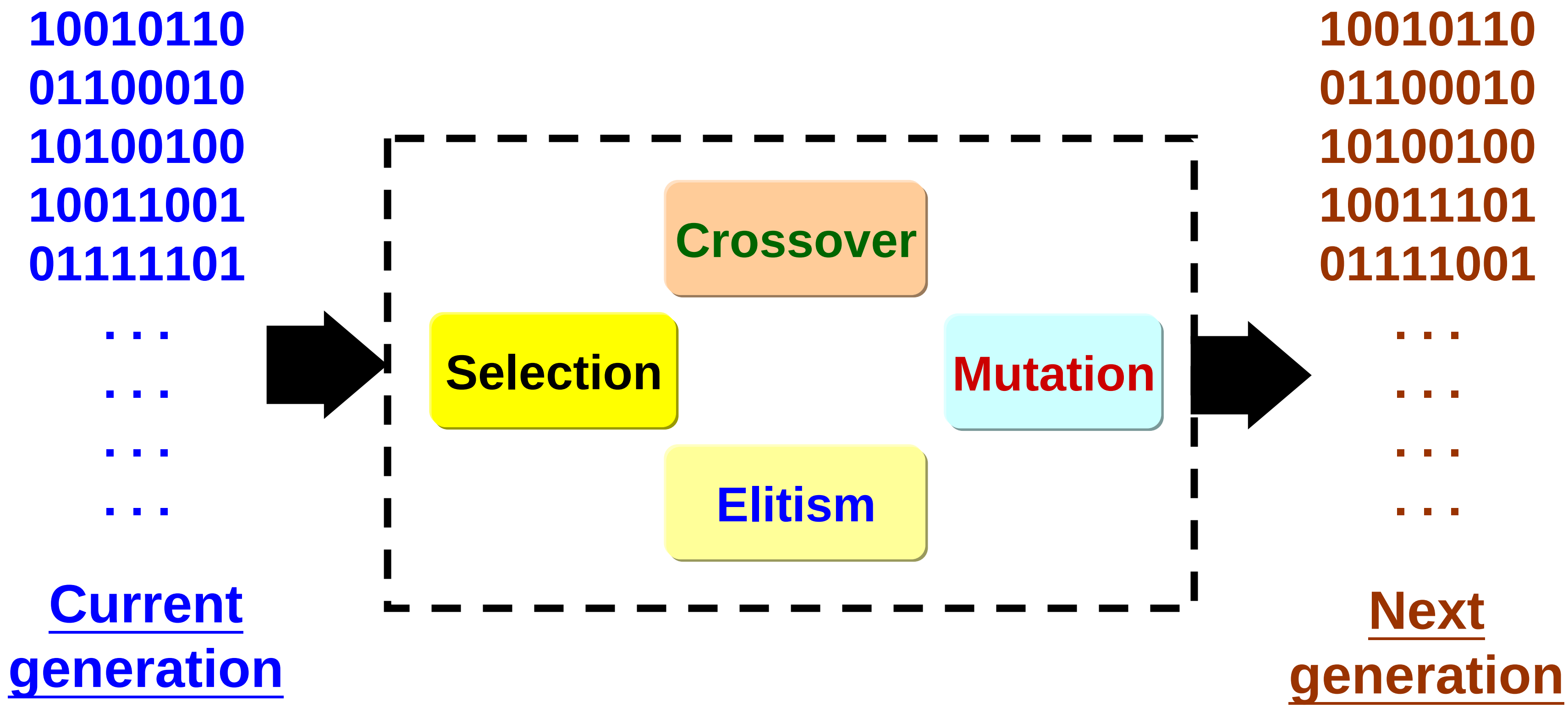
Limitations of RM

- There is an implicit assumption ***about the function being unimodal***.

Genetic Algorithms (GA) mimics laws of ***Natural Evolution*** which emphasizes "***survival of the fittest***".

In GA a "***population***" that contains different possible solutions to the problem is created.

Genetic Algorithms (GA)



The process is repeated until ***evolution happens***

"***a solution is found!***"

Capabilities of GA

- In contrast to traditional techniques, ***GA is the most likely technique to find global peaks*** than traditional techniques.

Limitations of GA

-Unlike traditional optimization methods, ***GA is not the best module for handling continuous variables***

- ***Relative fitness*** depends on probabilistic criteria of the variables that ***might be unknown***.

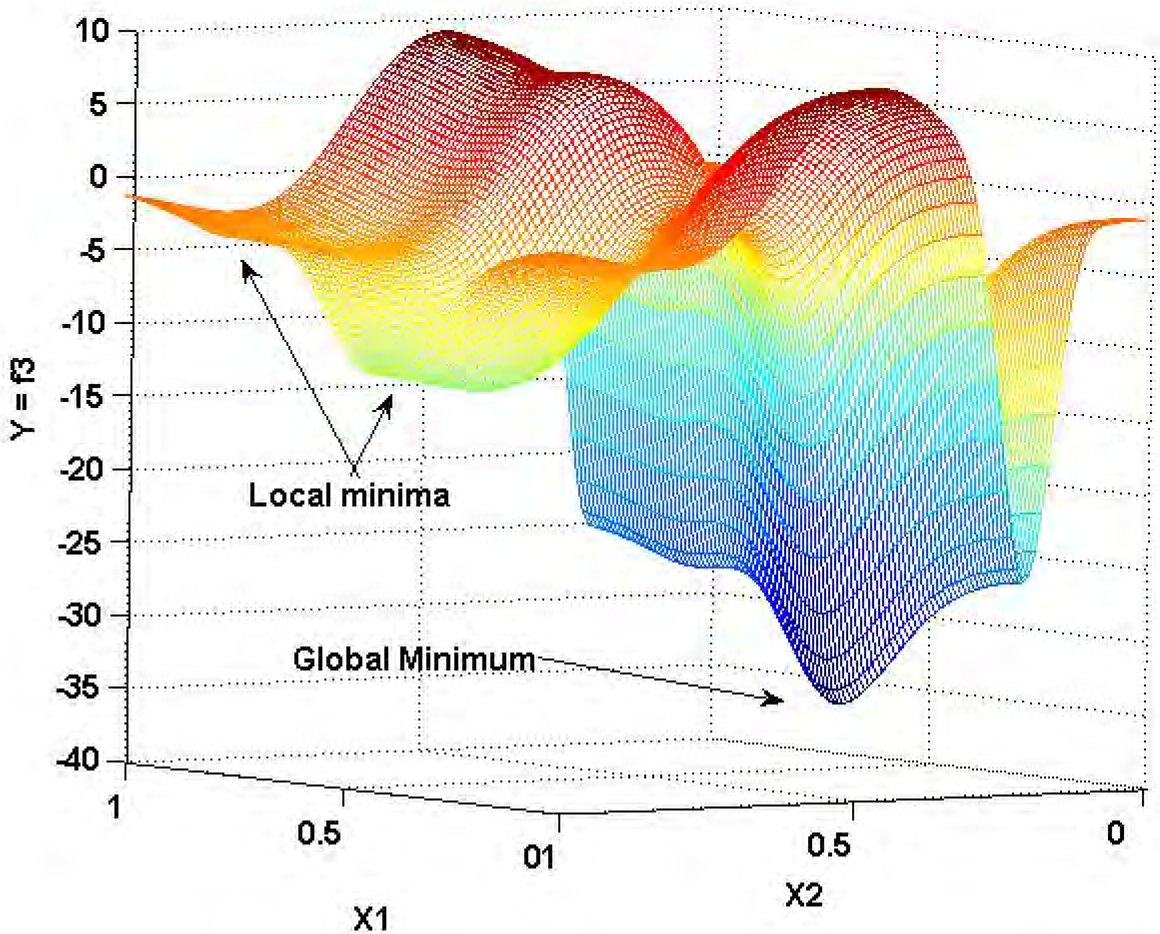
Comparison between GA and RM

-We have conducted a series of ***research experiments*** to compare efficiency of the RM and GA for ***functions*** with ***different levels of complexity.***

- We examined the methods on two, three, four dimensional multivariates.

- We present here example results for optimizing ***a two dimensional multivariate Gaussian functions.***

Comparison between GA and RM



Two dimensional multivariate Gaussian functions

Comparison between GA and RM

Method	Iteration #	x_1	x_2	y	
RM	1st Iteration 1000 iterations	0.816	0.422	-12.89	LM
	2nd Iteration 1000 iterations	0.815	0.753	-4.71	LM
	3rd Iteration 1000 iterations	0.198	0.422	-35.27	GM
GA	1st Iteration 50 generations	0.198	0.423	-35.27	GM
	2nd Iteration 50 generations	0.191	0.440	-34.84	GM

Comparison between GA and RM

-It became obvious that **RM** ***is very sensitive to the starting point*** of the search. This is why RM algorithm ***fell in almost all local minima***

- On the contrary, **GA** is ***not sensitive to initial start*** and its temporal performance is better than RM.

- ***However***, it is well known that ***there is no optimal choice for optimization methods***, they are ***problem-dependent*** and thus ***further research is needed***.

Example Application of GA

GA for Optimal Defense Measures Identification

- Here we used the **EGM using ANFIS** ***as the relation model*** and ***examined*** using ***GA*** to ***identify the optimal defense measures*** ($\hat{\theta}$) for a given attack engagements.

- We operated the DS tool in
  - ***Exploration mode to validate EGM***
  - ***Optimization model to examine GA***

Exploration Mode

Engagement Description

CB attack on a U.S. Air force in the Persian Gulf

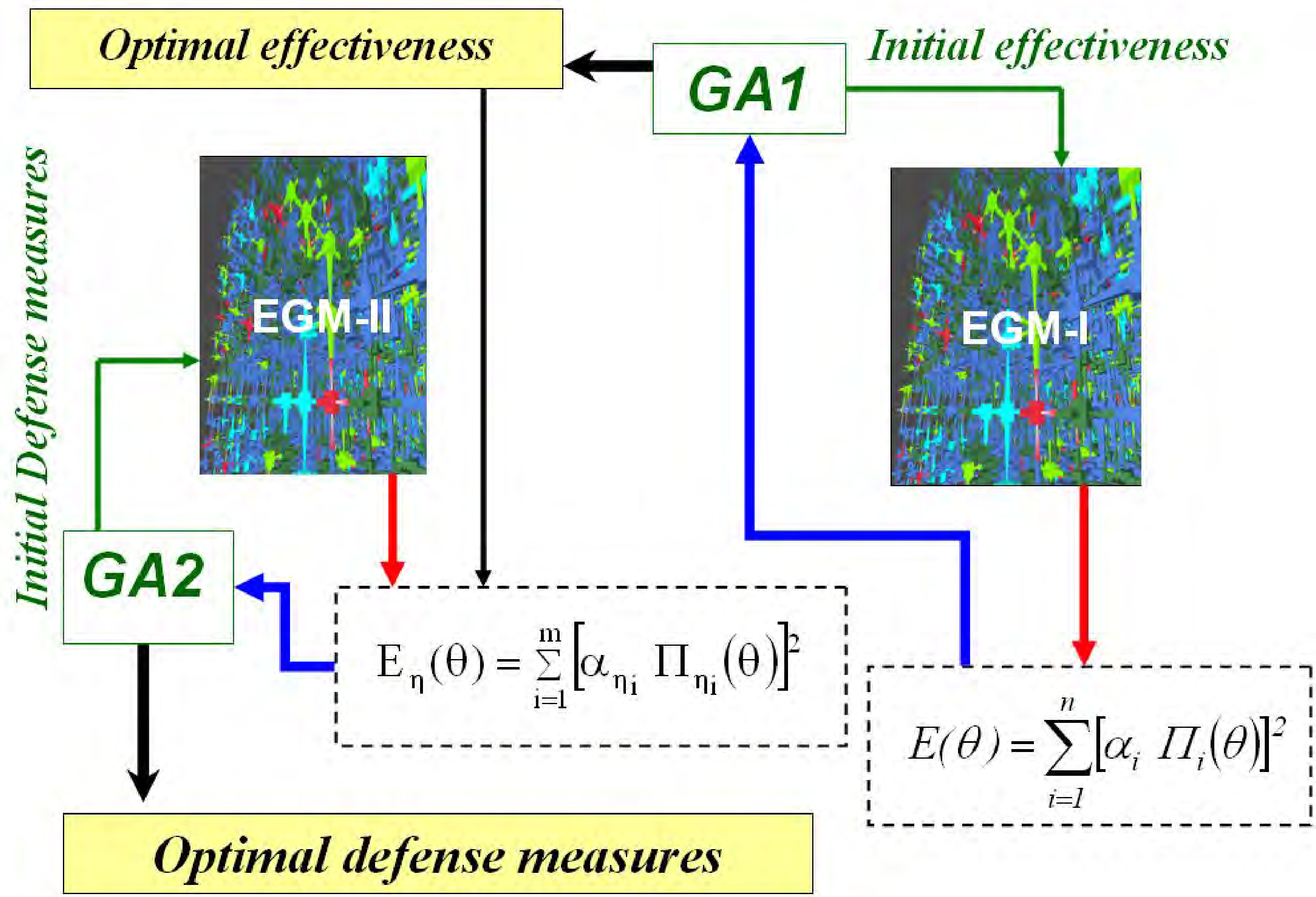
- ***Preparator***: Hostile foreign state
- ***Motivation***: Interrupt Strategic functions
- ***Military facilities***: Flight operation and support
- ***Chemical/Biological agent***: Vx
- ***Dispersal mechanism***: Missile warhead: Cluster
- ***Point of Release***: 2km SE of personnel area
- ***Other characteristics…..***

Exploration Mode

Consequences		Var 1	Var 2	Var 3
Casualties	Expected	150-350	150-250	150-250
	Model	**377**	**263**	**346**
Cost (US $ M)	Expected	70	65	60
	Model	**72**	**57**	**65**
Days of Int.	Expected	7	5	5
	Model	**7**	**5**	**5**

- EGM sensitivity to defense measures was examined.

Two stage GA


Optimal effectiveness
GA1
Initial effectiveness
EGM-II
EGM-I
Initial Defense measures
GA2
$E_{\eta}(\theta) = \sum_{i=1}^{m}\left[\alpha_{\eta_i} \Pi_{\eta_i}(\theta)\right]^2$
$E(\theta) = \sum_{i=1}^{n}\left[\alpha_i \Pi_i(\theta)\right]^2$
Optimal defense measures

Optimization Mode

- Predefined consequences include

Predefined level of Consequences	
Casualties	430
Remediation Cost $M	70
Days of Int.	7
Cost of Add. S&T $M	170

Optimization Results

The output of the ***optimization module*** was 250 ***possible combinations of defense measures*** that will

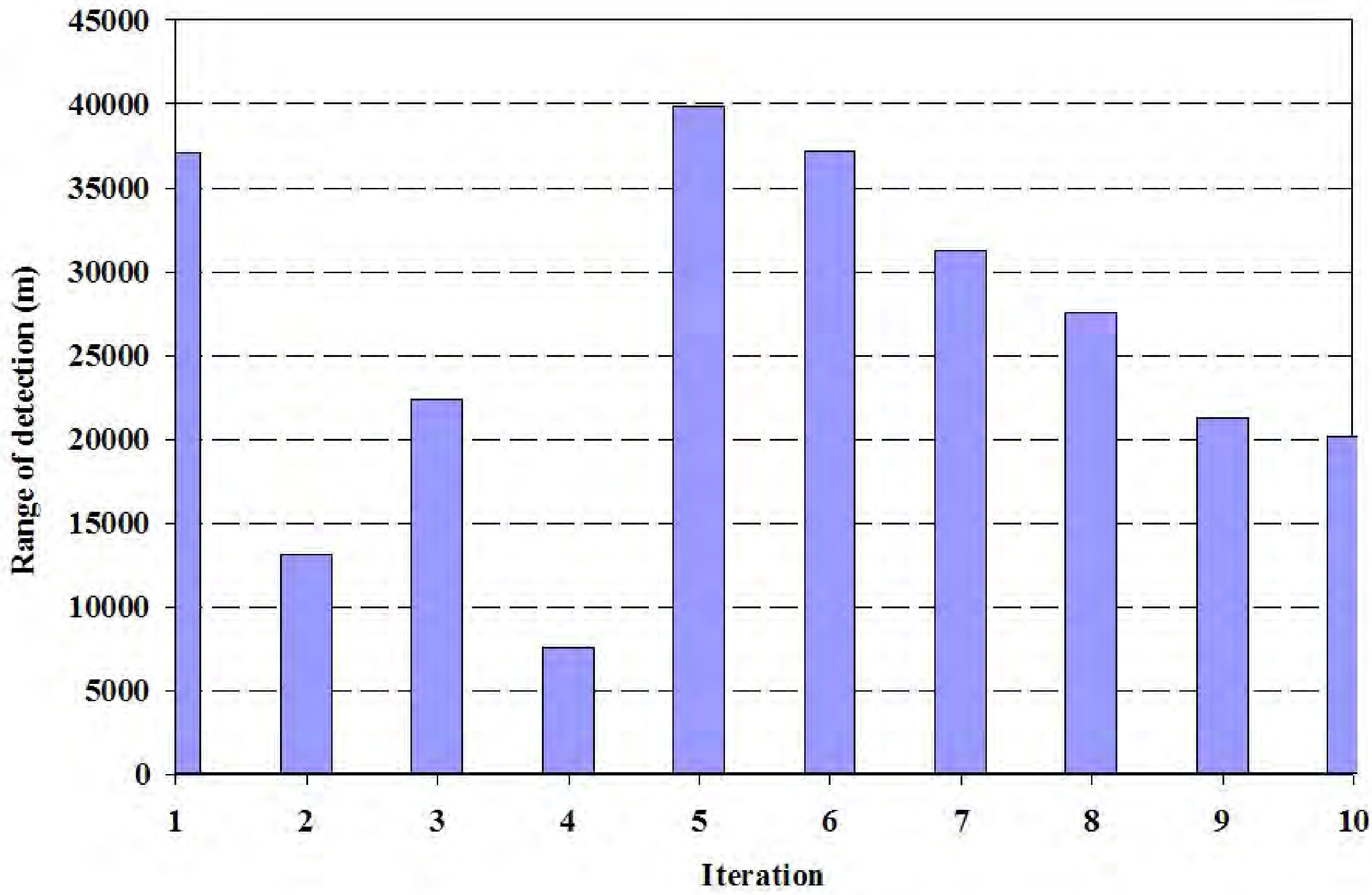
- Achieve a level of minimum ***consequences***

- Limit the ***S&T*** dollars to the total available fund

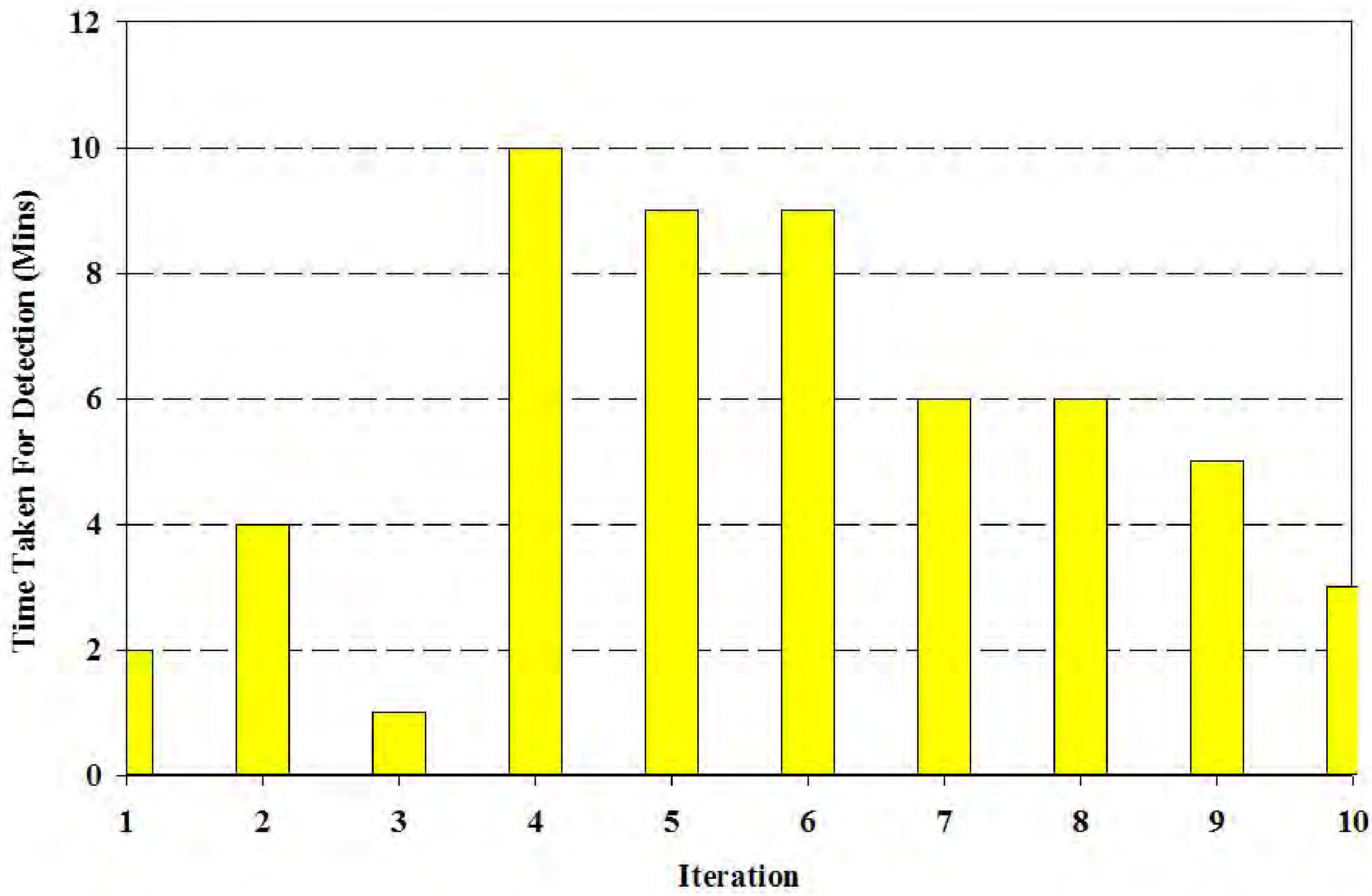
The question becomes

Which solution to choose?

Possible solutions



Possible solutions



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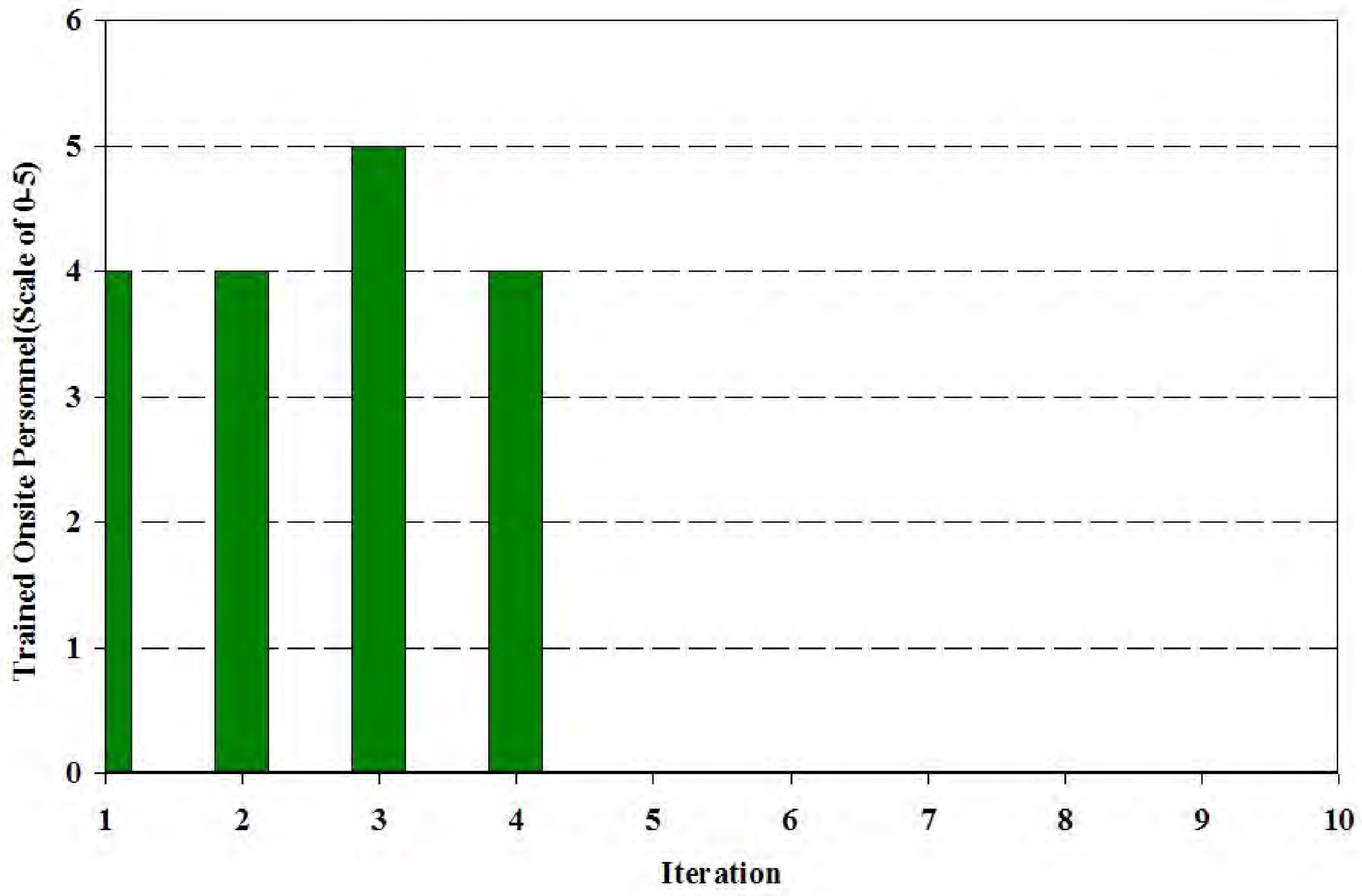

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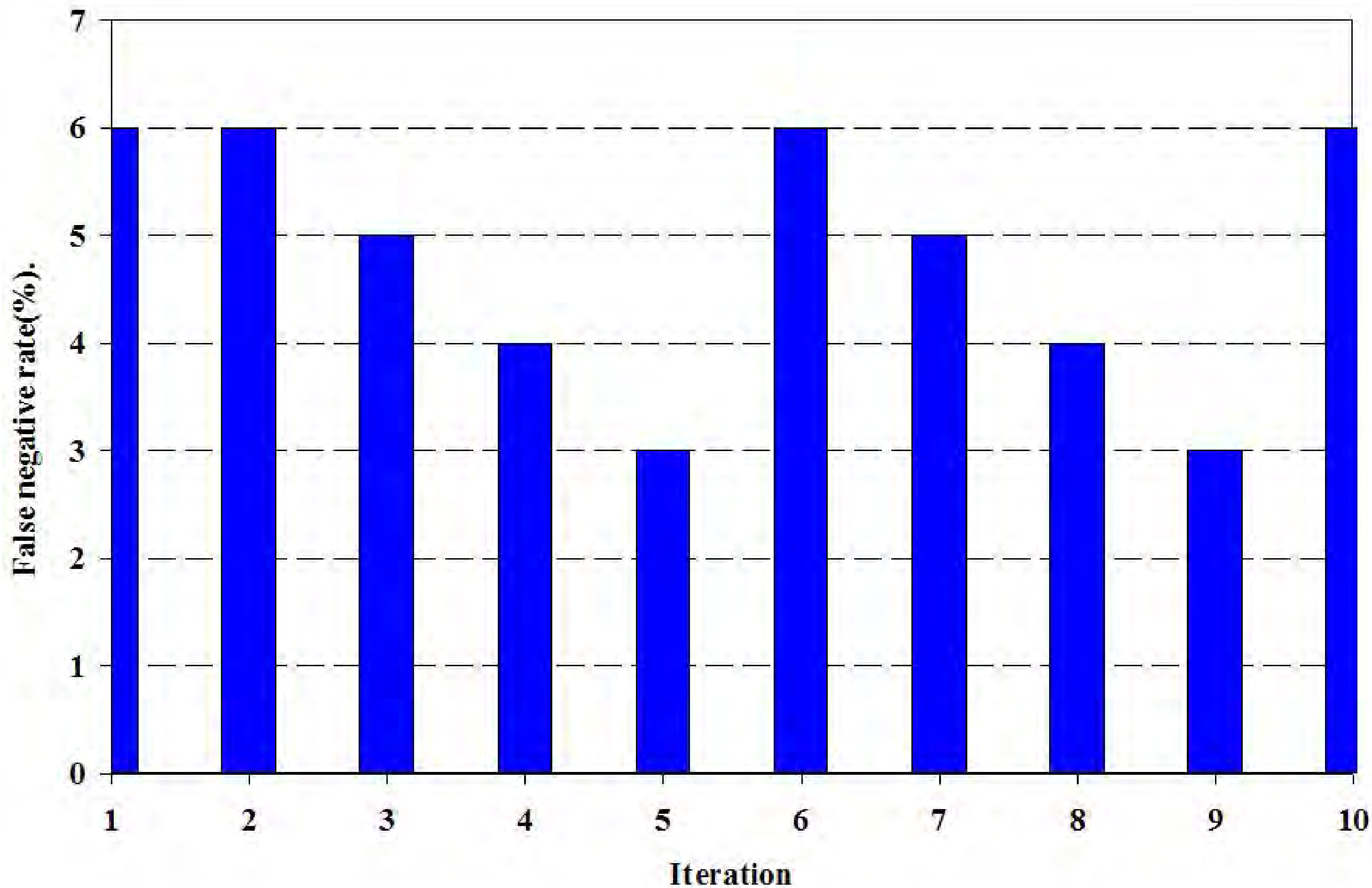
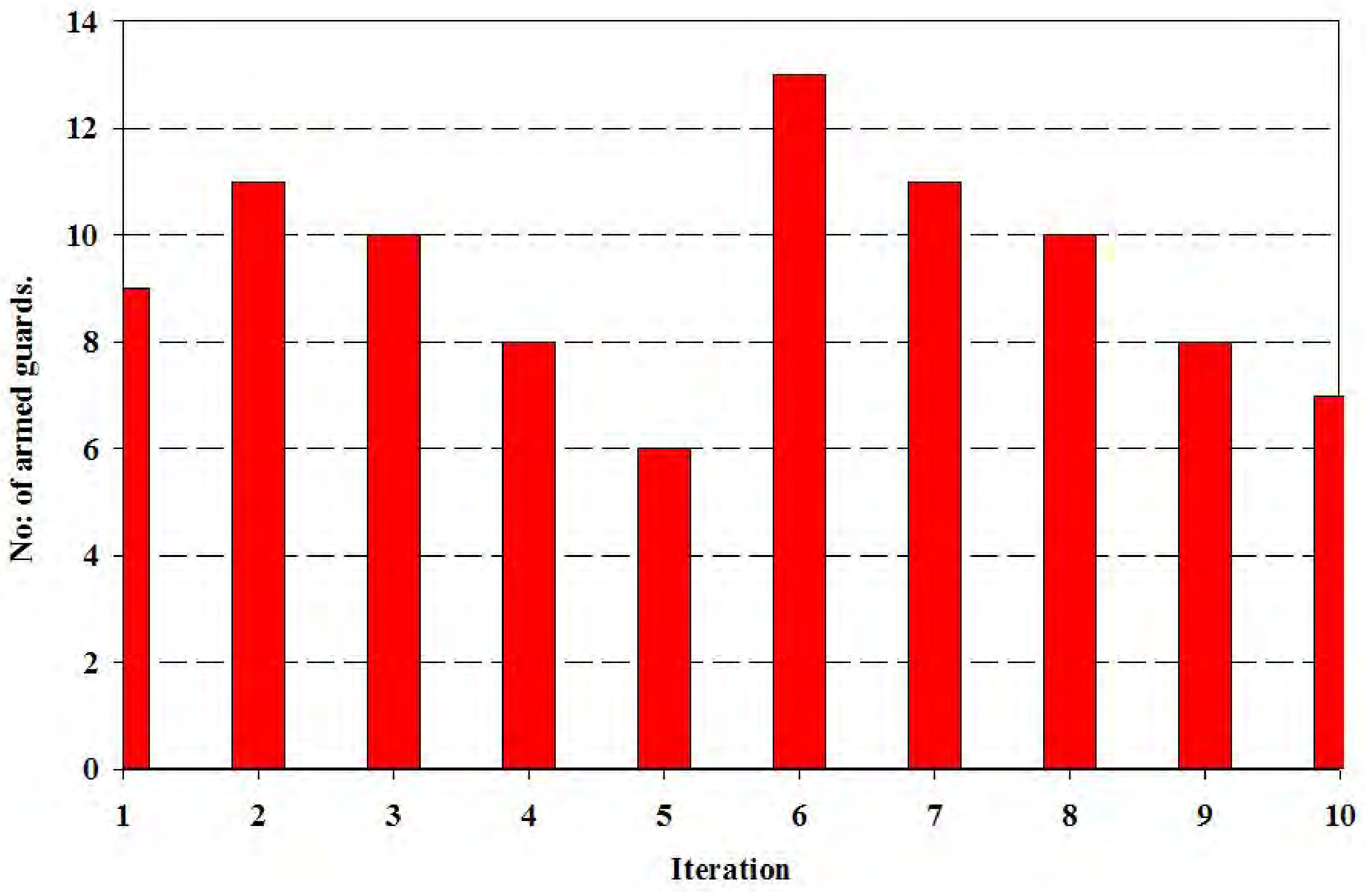


Possible solutions



Rank ordering

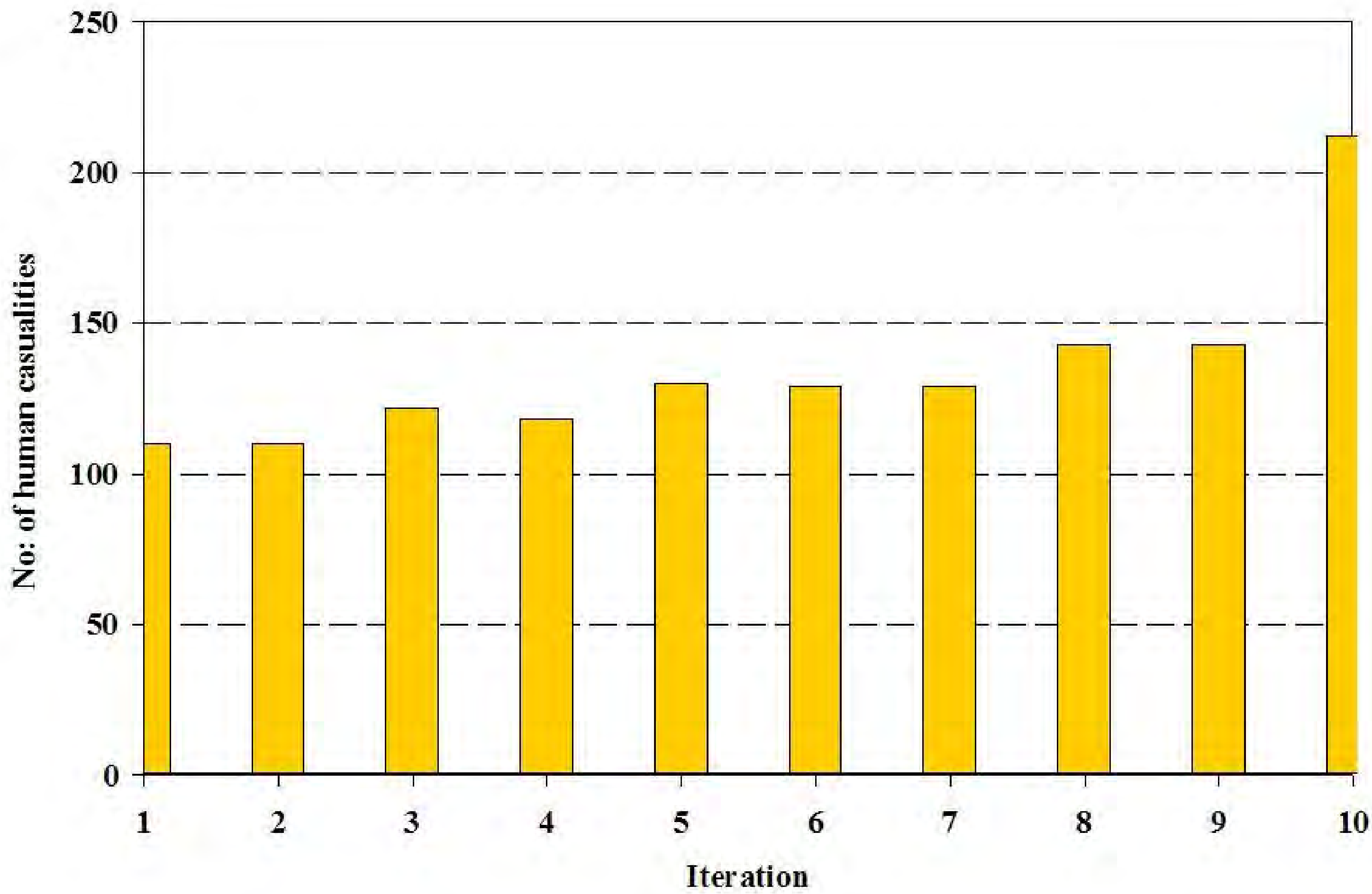
In our problem, ***ranking criteria are interactive***. In such a situation, ***it is proved in decision theory that nonlinear aggregation operators are more efficient***.

A few possible techniques

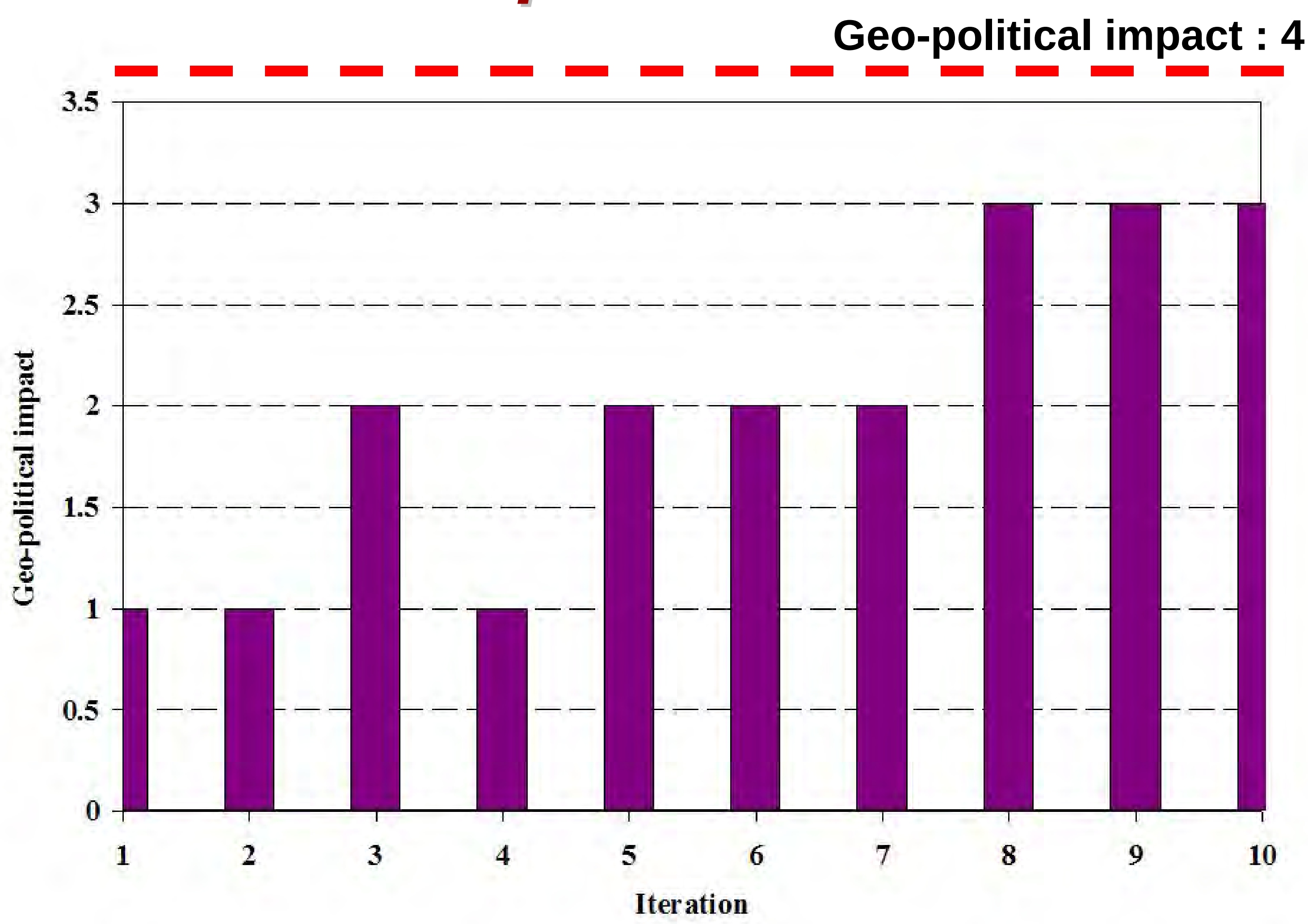
- ***Choquet Integral (CI)***
- ***Multi criteria decision making (MCDM)***

Consequences If optimal defense measures are implemented

Threshold : 430



Consequences If optimal defense measures are implemented



Conclusions

-We demonstrated the possible use of derivative-free optimization as an efficient system for optimization for finding the optimal S&T investments to minimize the consequences of CB attacks

-A two step optimization using GA proved more efficient than a one-stage optimization methods in performing the analysis

- The optimization tool showed good accuracy in finding the optimal defense measures to minimize consequences due to CB attacks

- Research is currently on-going to integrate this method with rank ordering module.

Acknowledgment

This research is funded by Defense Threat Reduction Agency (DTRA).

The authors gratefully acknowledge this funding.

Questions

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- The general architecture

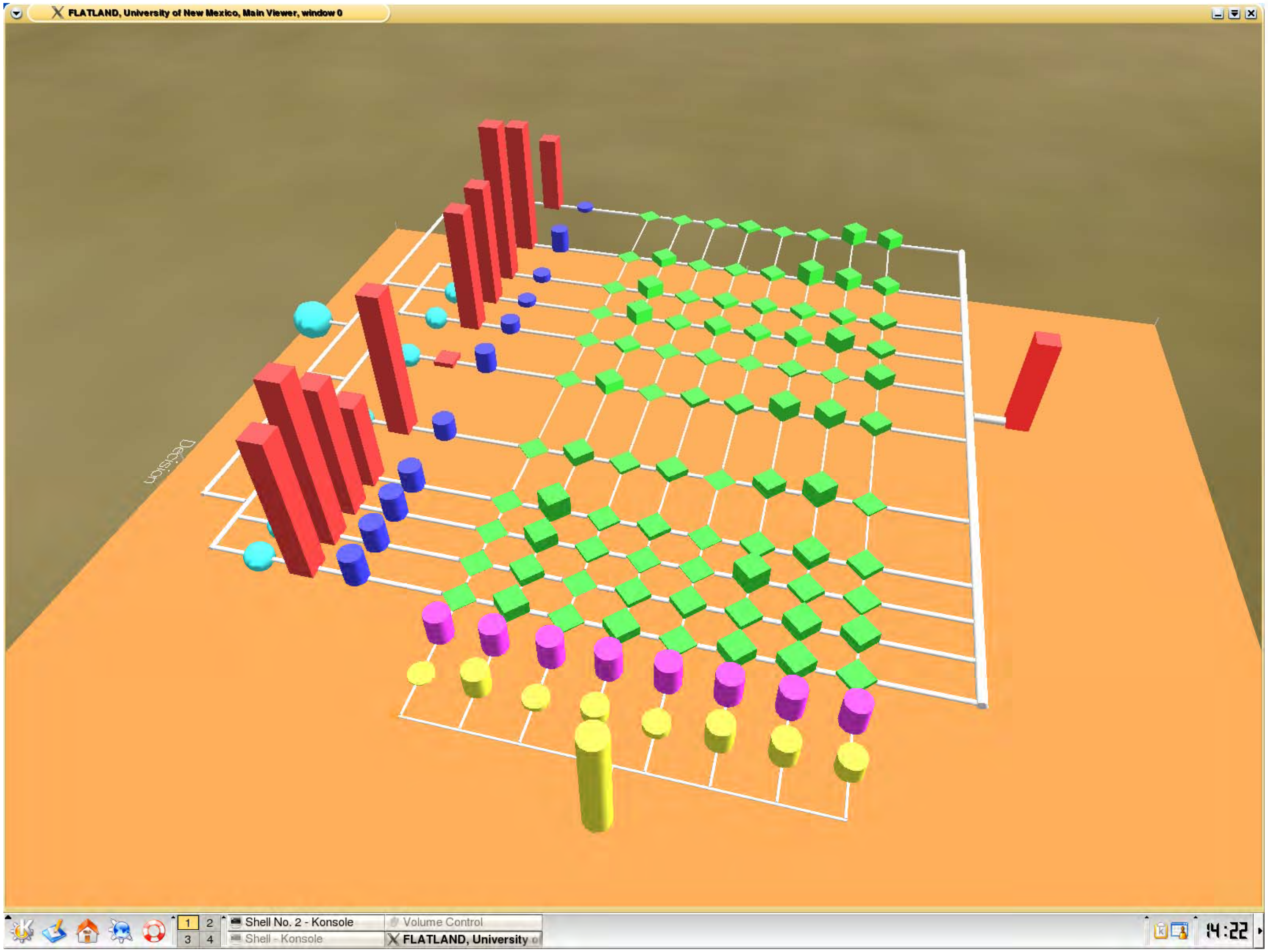
- How the analytic tool relates to the architecture

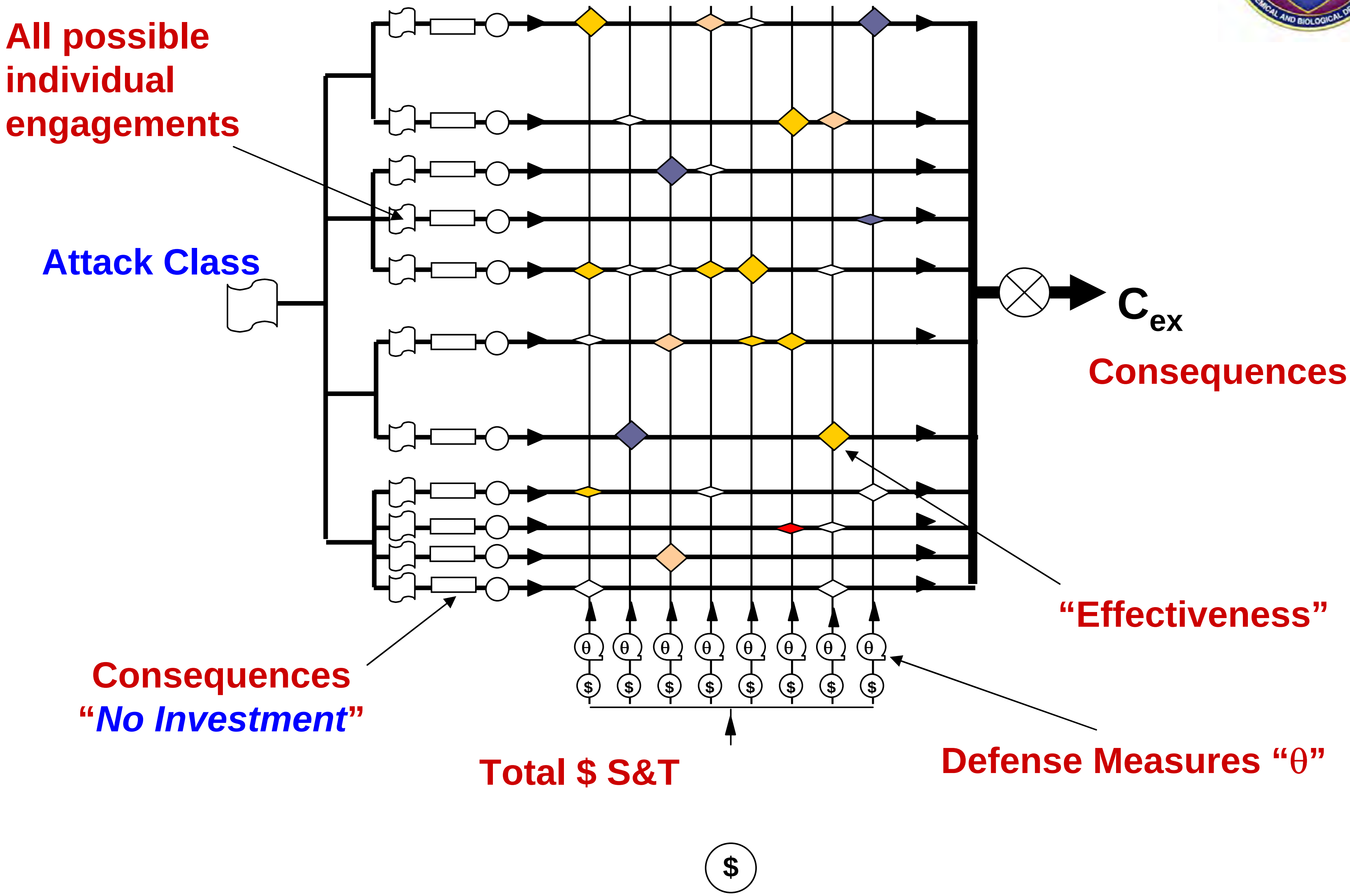
- Optimization mode: the problem

- Optimization Techniques With Example Application

- Conclusions

The General architecture





All possible individual engagements
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C_{ex}
Consequences
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Consequences
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Total $ S&T
Defense Measures "θ"
θ
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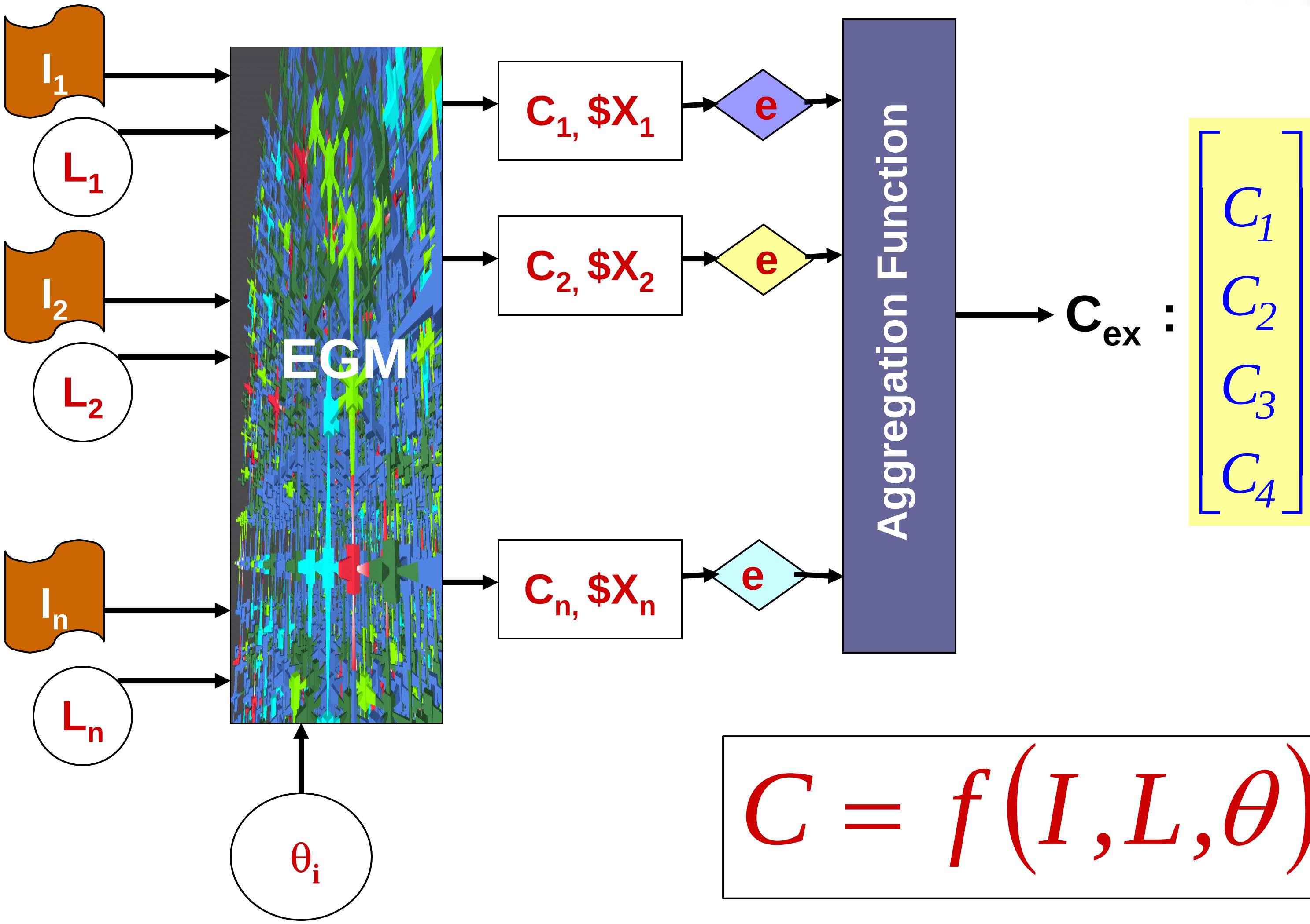
The Analytic Tool "Exploration Mode"



$$C = f(I, L, \theta)$$

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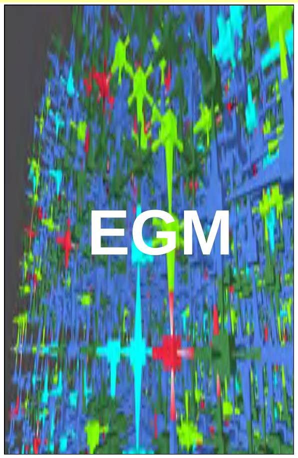
Analytic Toolbox

- Three main components

Component I:



Component II:

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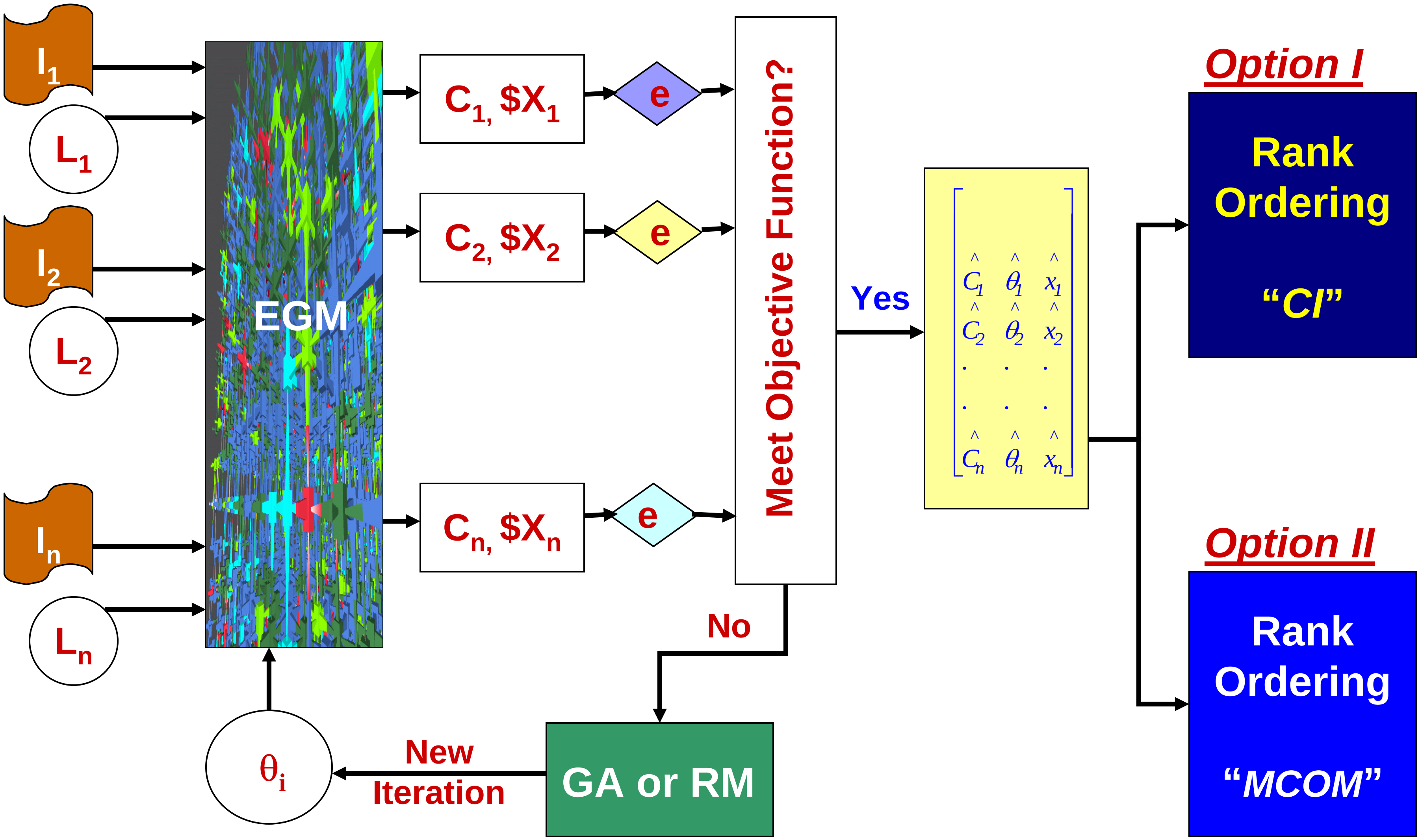
Focus of this talk

The Analytic Tool: "Optimization Mode"



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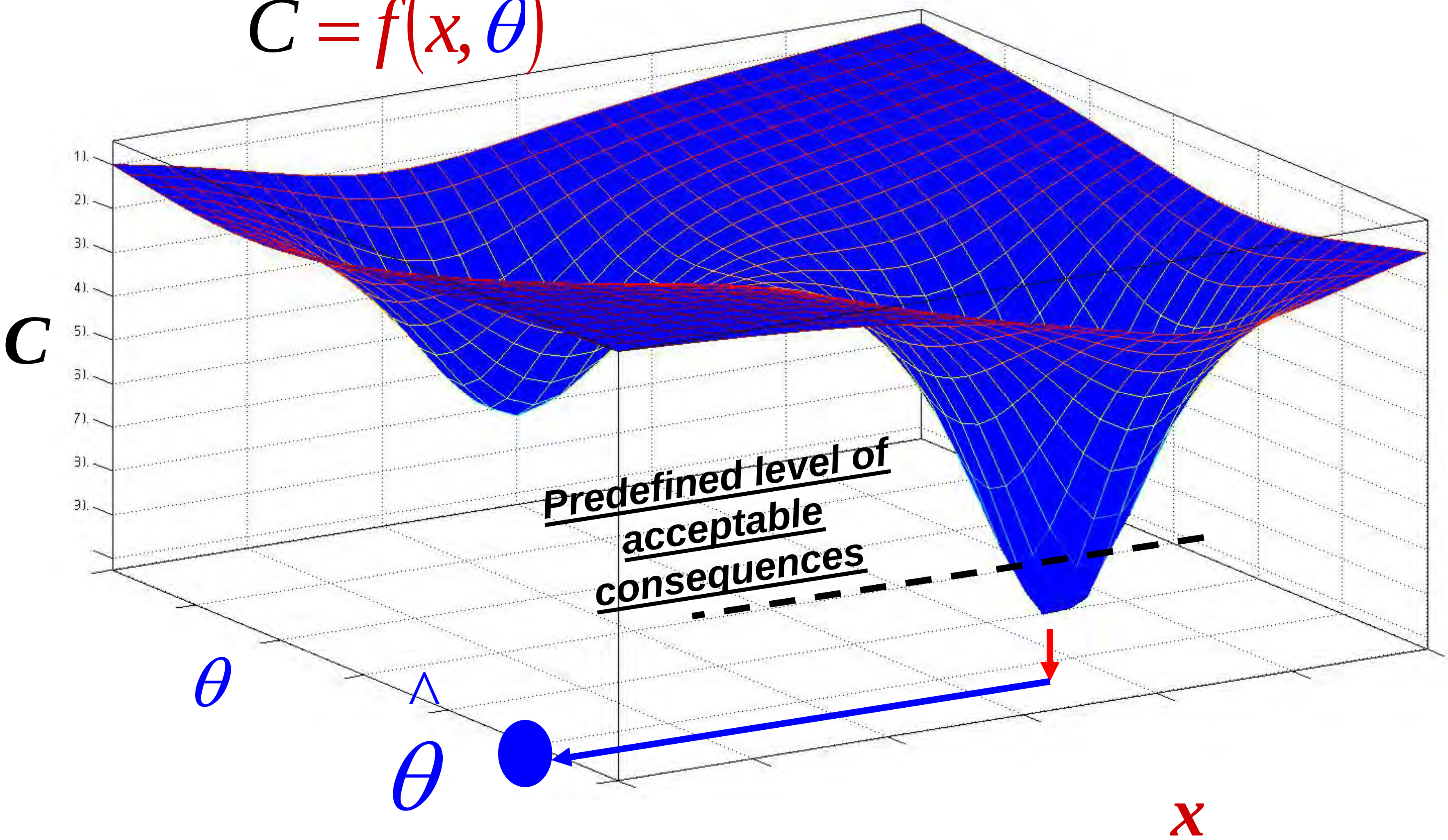

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When ***the function is unknown***, an established technique ***is to minimize the error*** (squared error) between the ***desired output*** and the ***model's output***.

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$$E(\theta) = \sum_{k=1}^{n} \left(C_{desired} - f(x, \theta) \right)^2$$

Objective function

Two optimization approaches can be used here

<u>Derivative-based</u>

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<u>Derivative-free</u>

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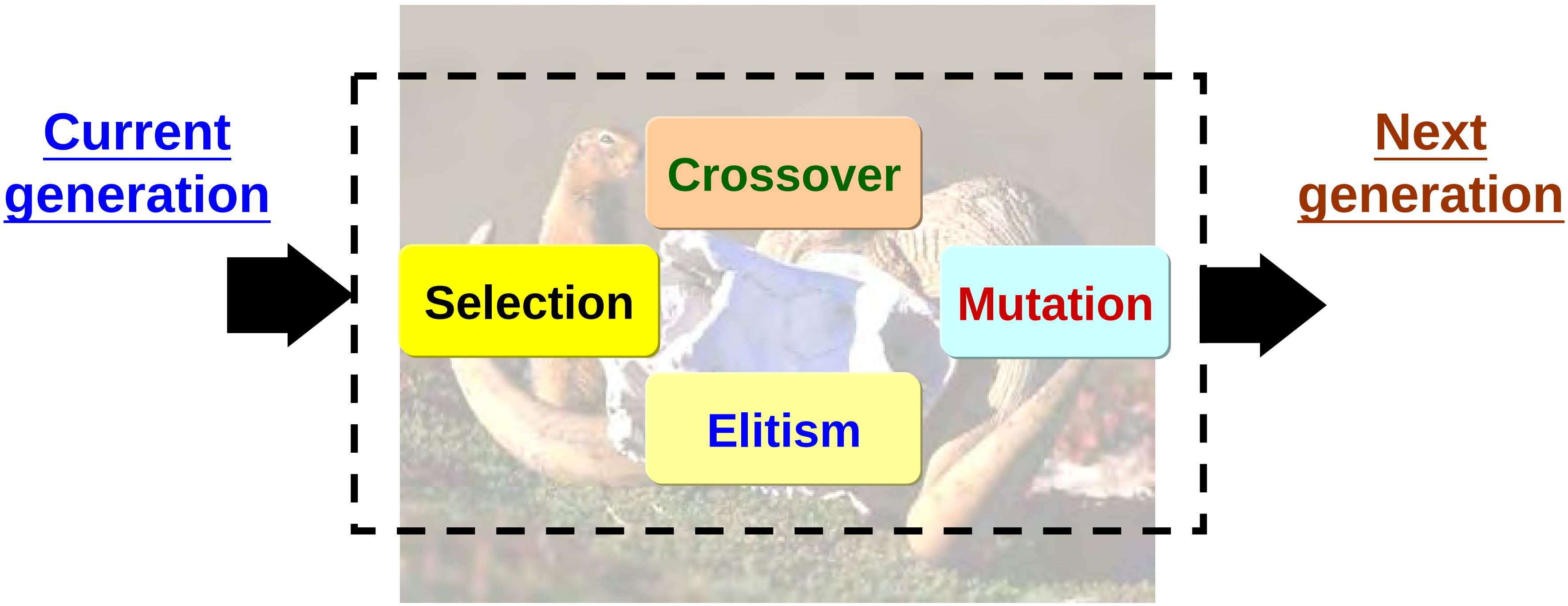

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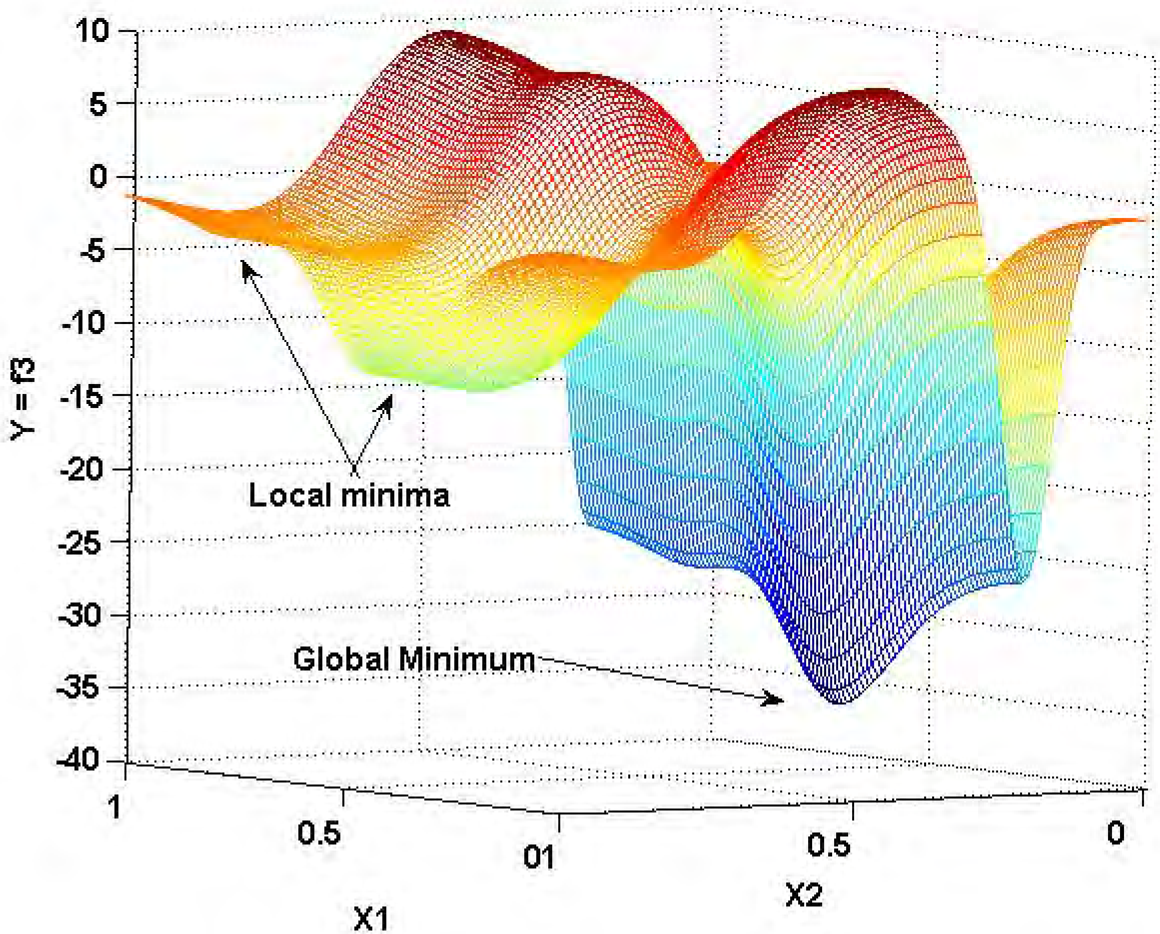
A Three dimensional surface



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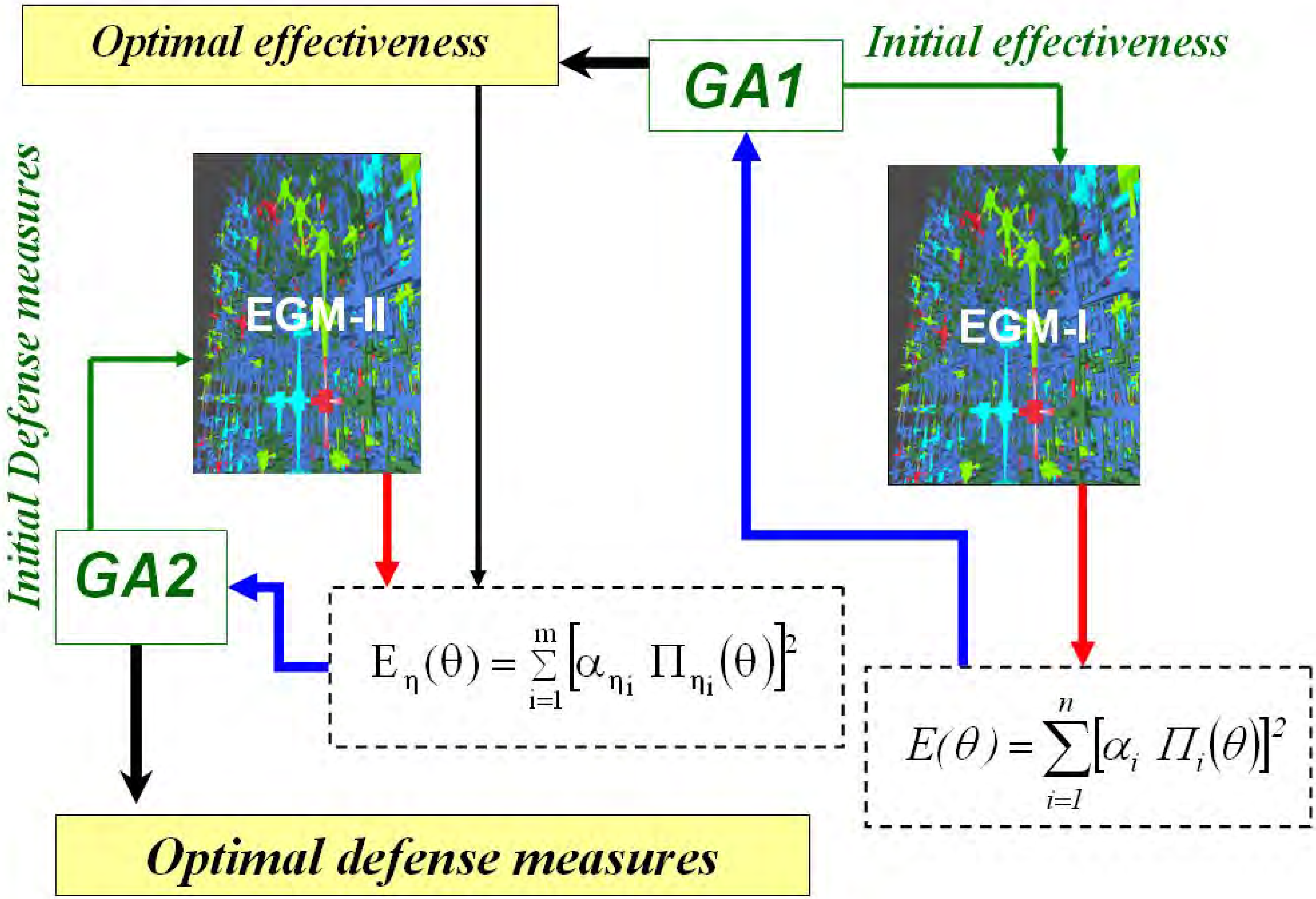
Two stage GA



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Initial effectiveness
Initial Defense measures
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EGM-I
GA2
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Optimal defense measures

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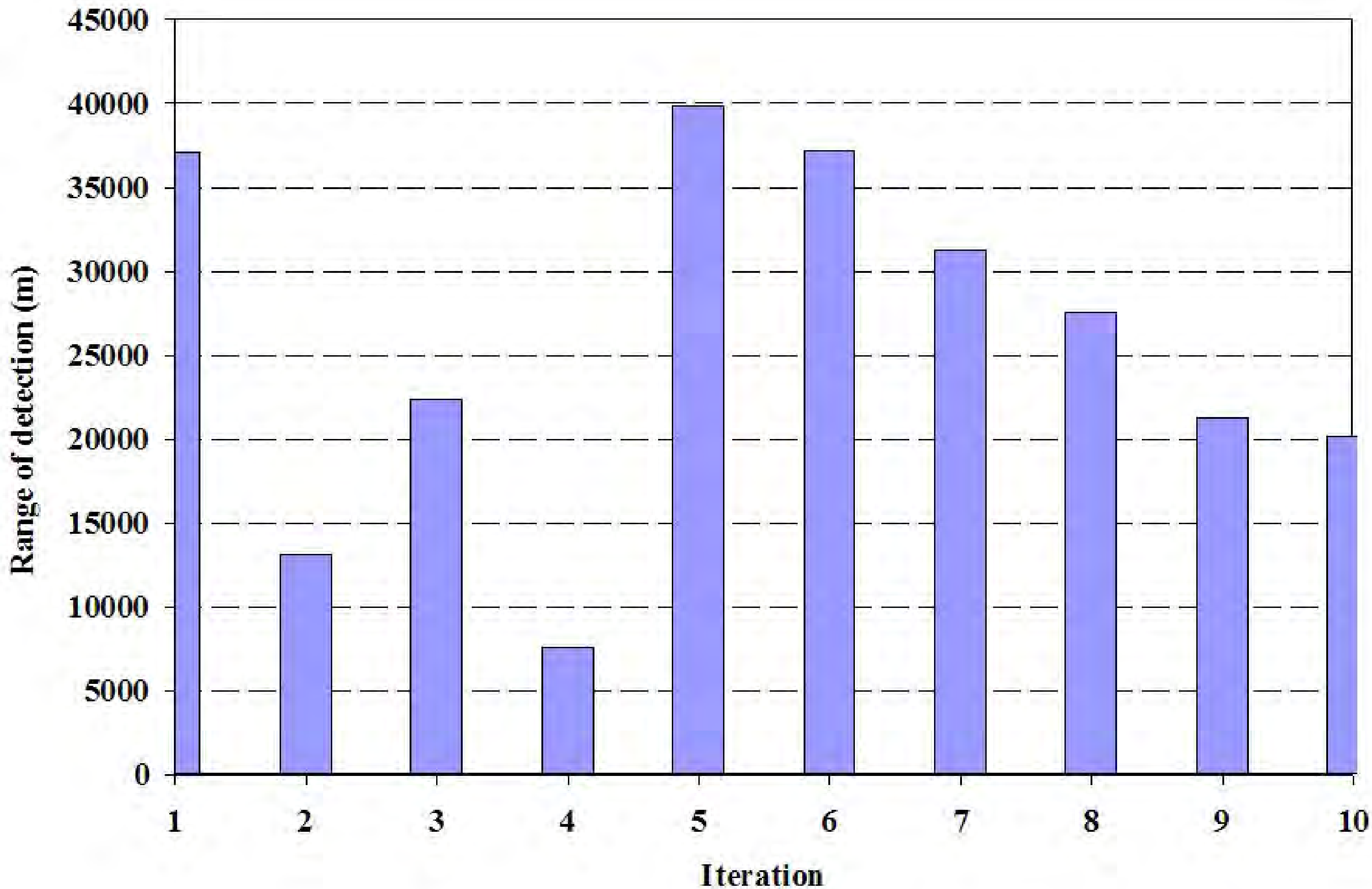
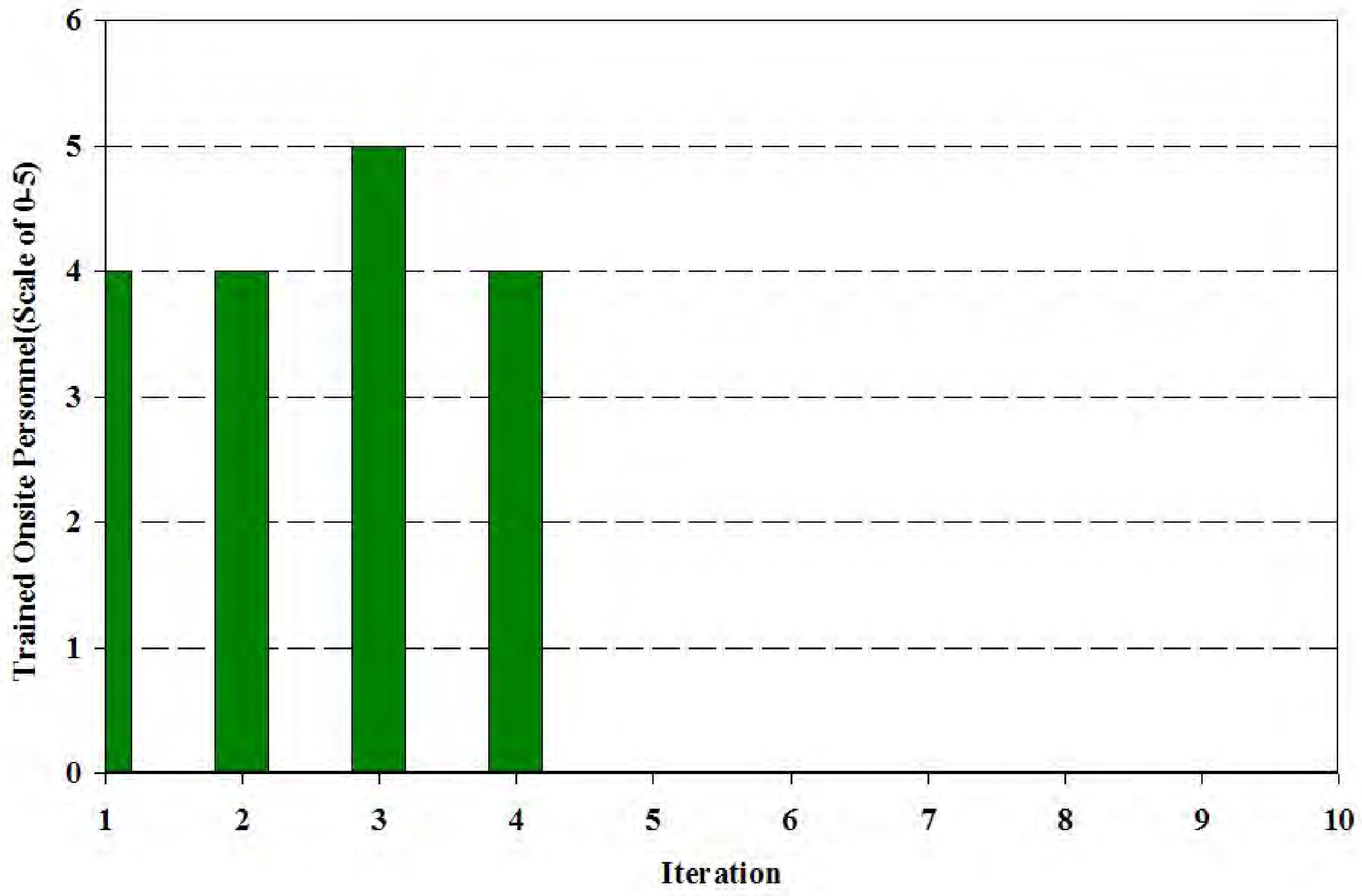


Possible solutions

Possible solutions



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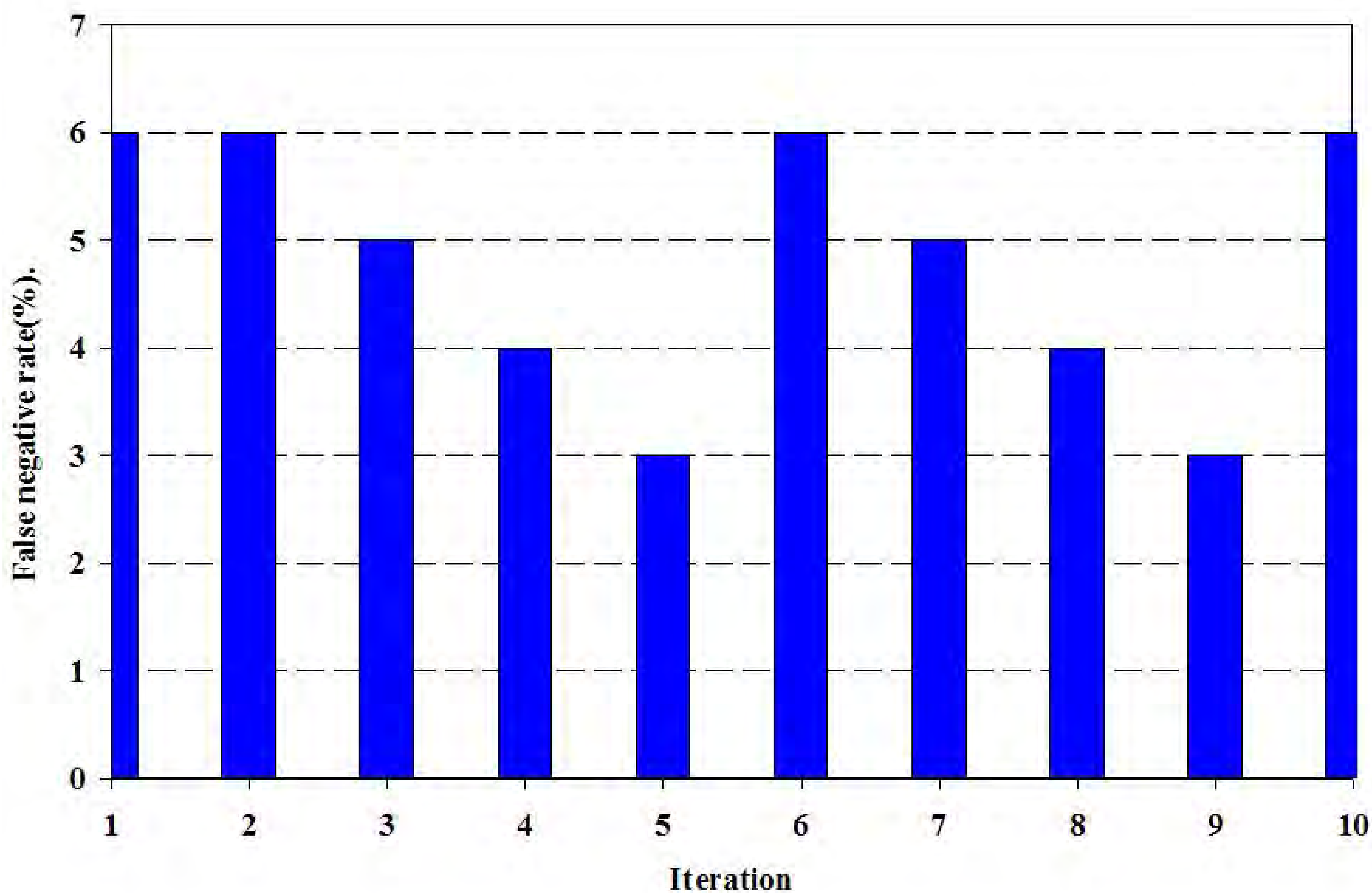

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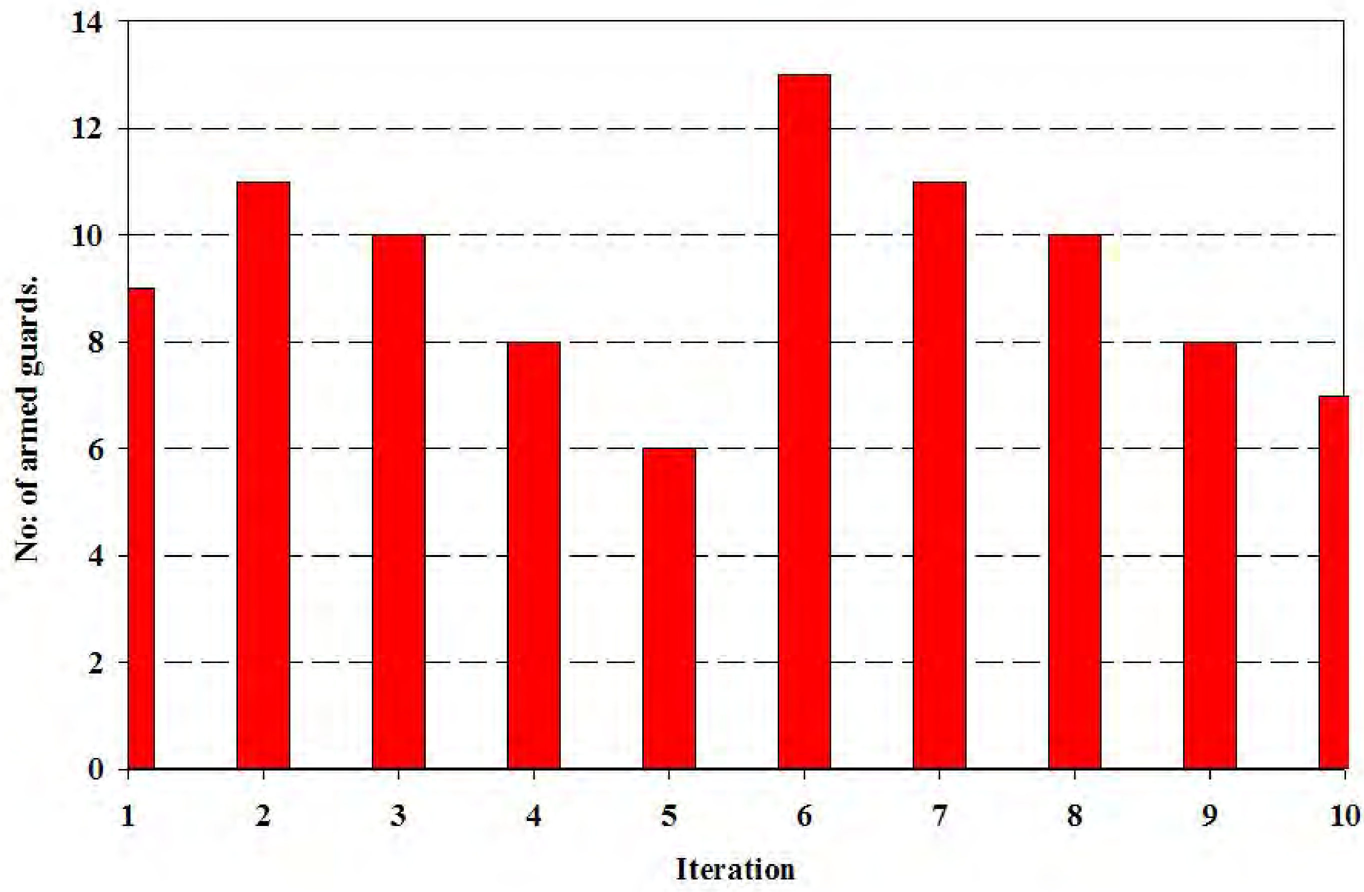
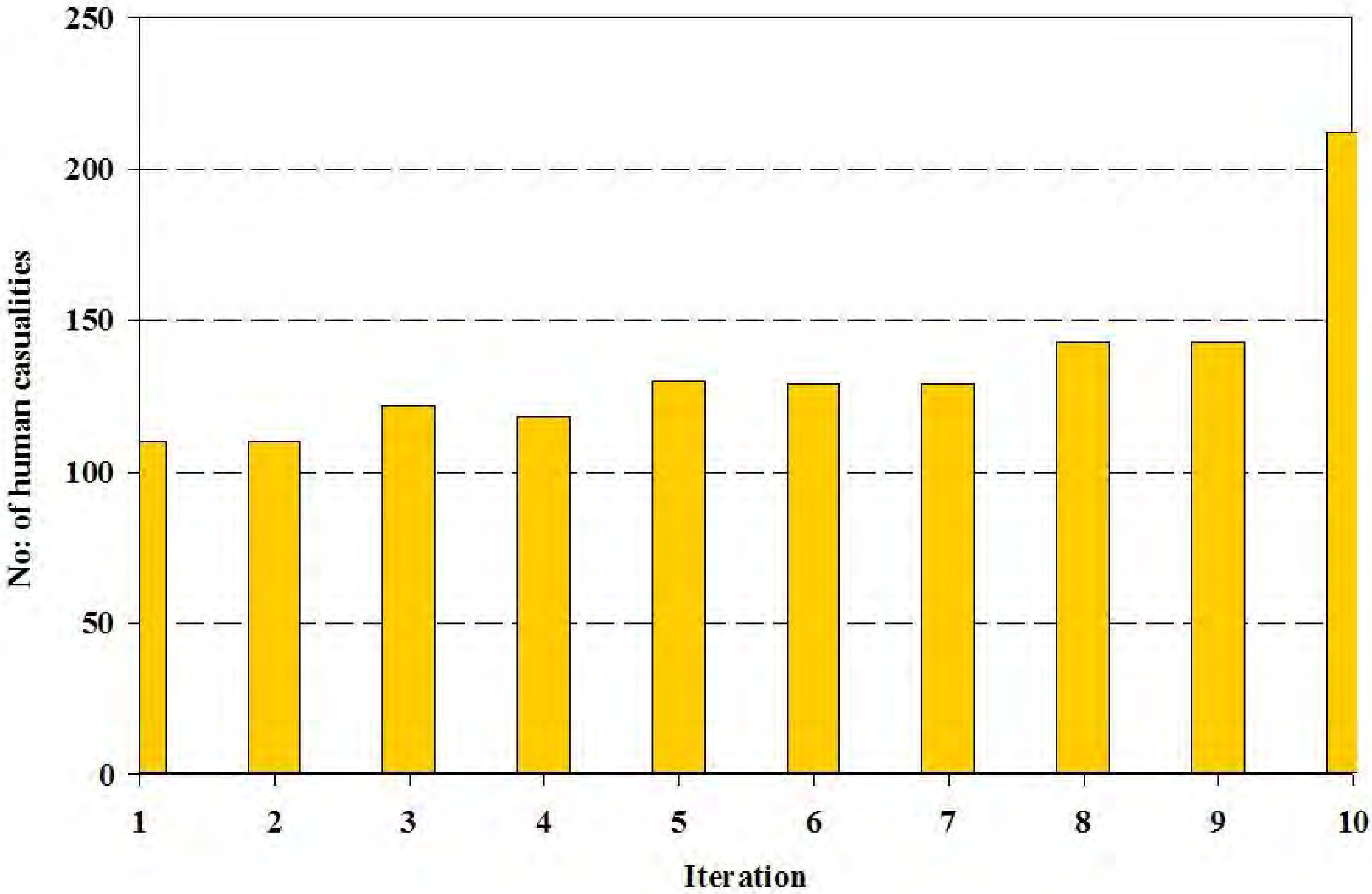
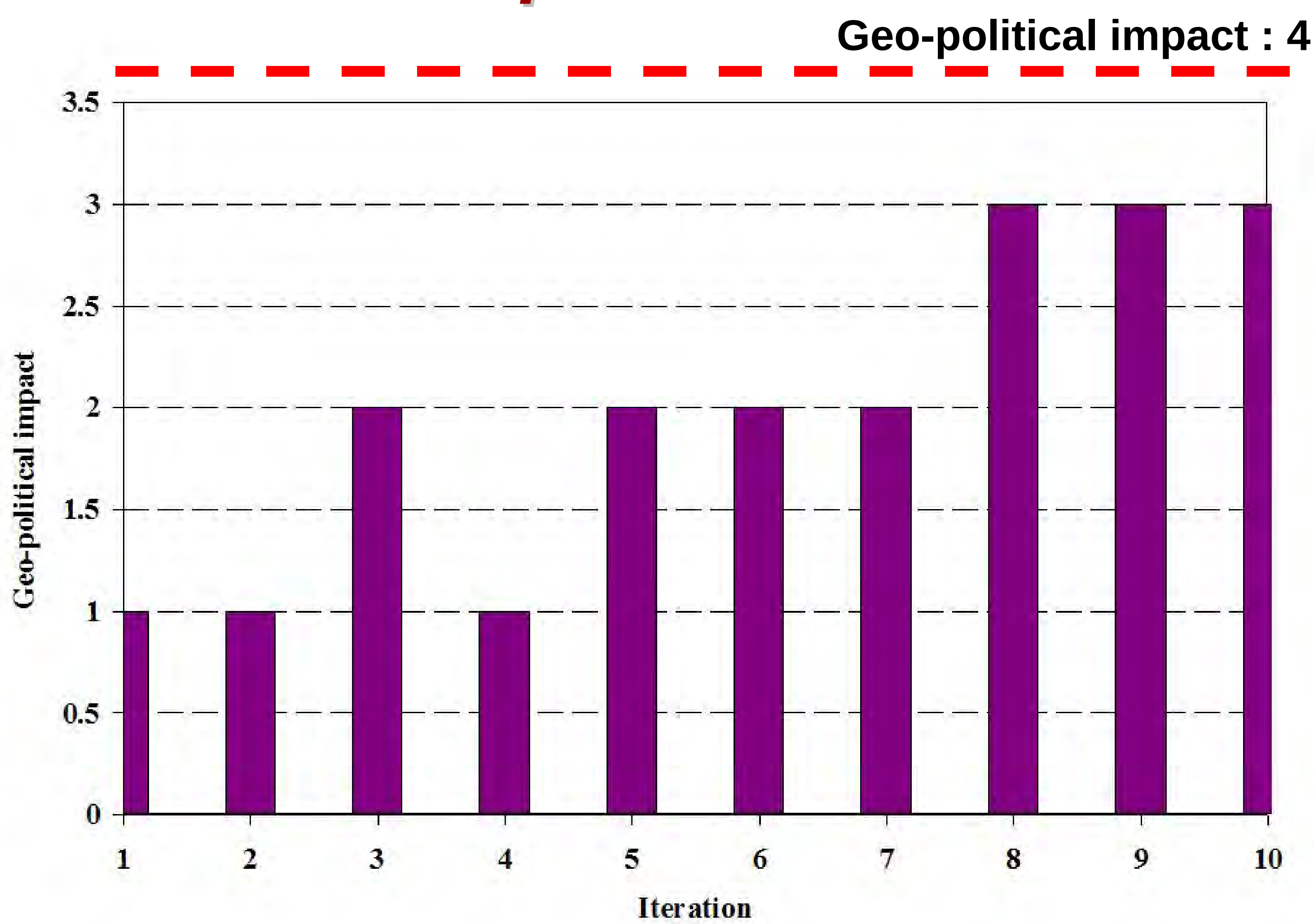


Consequences If optimal defense measures are implemented

Threshold : 430



Consequences If optimal defense measures are implemented



Rank ordering

In our problem, ***ranking criteria are interactive***. In such a situation, ***it is proved in decision theory that nonlinear aggregation operators are more meaningful and efficient***.

A few possible techniques

- ***Choquet Integral (CI)***

- ***AHP (Analytical Hierarchy Process)***

Conclusions

-We demonstrated the possible use of derivative-free optimization as an efficient system for optimization for finding the optimal S&T investments to minimize the consequences of CB attacks.

-A two step optimization using GA proved more efficient than a one-stage optimization methods in performing the analysis.

- The optimization tool showed good accuracy in finding the optimal defense measures to minimize consequences due to CB attacks.

- Research is currently on-going to integrate this method with rank ordering module.

Acknowledgment

This research is funded by Defense Threat Reduction Agency (DTRA).

The authors gratefully acknowledge this funding.

Our invaluable colleagues:

Arjun Rangamani

Ryan Schnalzer

Questions ?

Development and Implementation of a Model for Predicting the Aerosolization of Agents in a Stack

Teri J Robertson, Douglas S Burns, Jeffrey J Piotrowski, Dustin B Phelps, Veeradej Chynwat and Eileen P Corelli

ENSCO, Inc.

Science and Technology for Chem-Bio Information Systems (S&T CBIS)

October 28, 2005

Outline

- Project Goals
  - Account for aerosol formation in EMIS scenarios
  - Implement results in atmospheric transport and dispersion and chemistry models
- The “Problem”
- Methodology
  - Aerosol formation algorithms
  - Model assumptions and limitations
  - Integration of STACK into EMIS
- Results
  - Model output
    - Example TEPO scenario
    - SLAM particulate results
- Model Sensitivity
  - Sensitivity Analysis
  - Physical property data
- Future Work

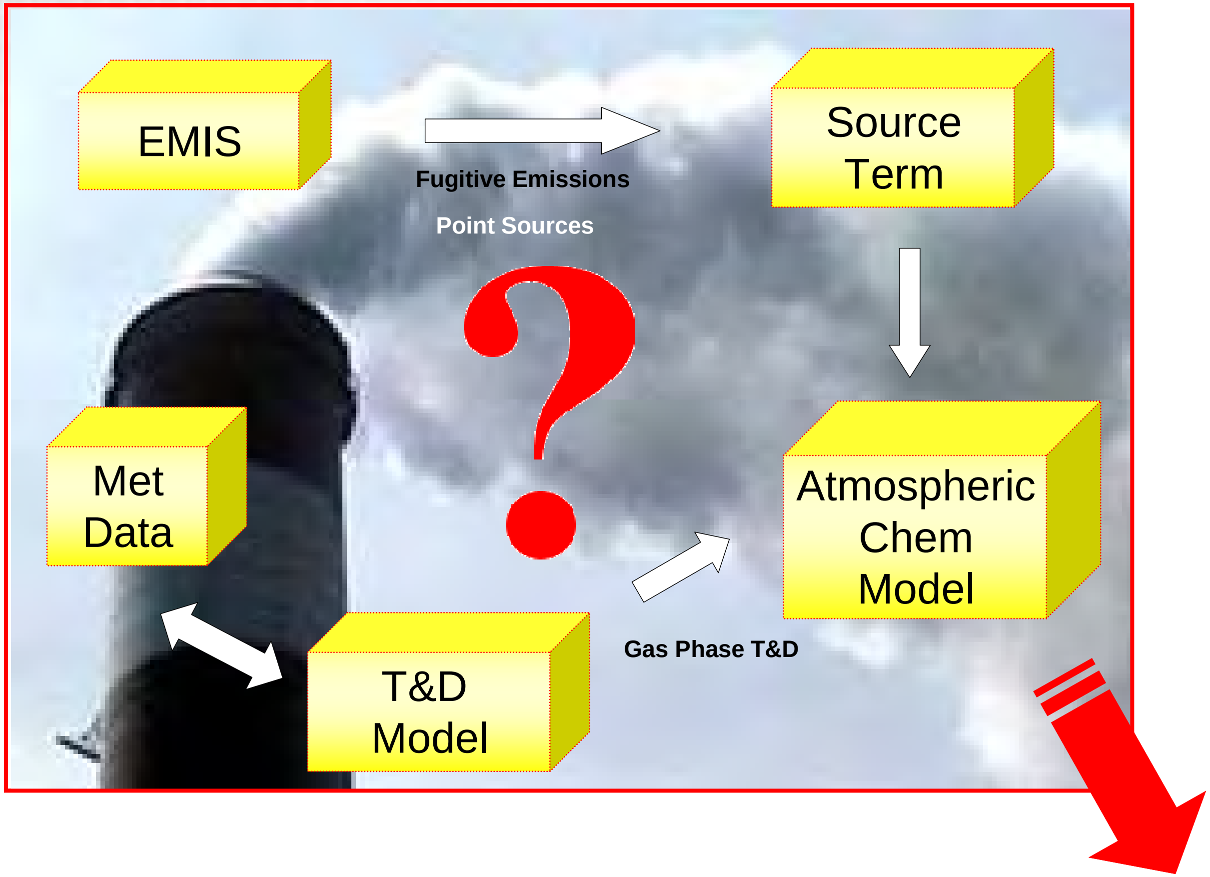
Project Goals

- **Adapt an aerosolization model**
  - Model must run rapidly
  - Code must be fairly "easy" to implement
  - Algorithms must handle streams with multiple components
  - Algorithm must be easily integrated with the EMIS (Emission Model for Industrial Sources) tool
  - Algorithm output must meet requirements for model input to AT&D (i.e., ChemCODE and SLAM)
- **Couple STACK model with EMIS**
- **Formulate output compatible with existing software suite**

The “Problem”

- Current model treats all emissions as gas phase
- Most OPs will condense to at least some extent at ambient conditions
- A TIC may condense at the stack and some may never even ‘see’ the transport and dispersion model!
- Result: overestimates downwind hazard prediction

The "Problem"



Downwind Hazard Prediction

Methodology: Governing Equations

$$\frac{\partial n_m}{\partial t} = r_A = -r_N - r_C$$

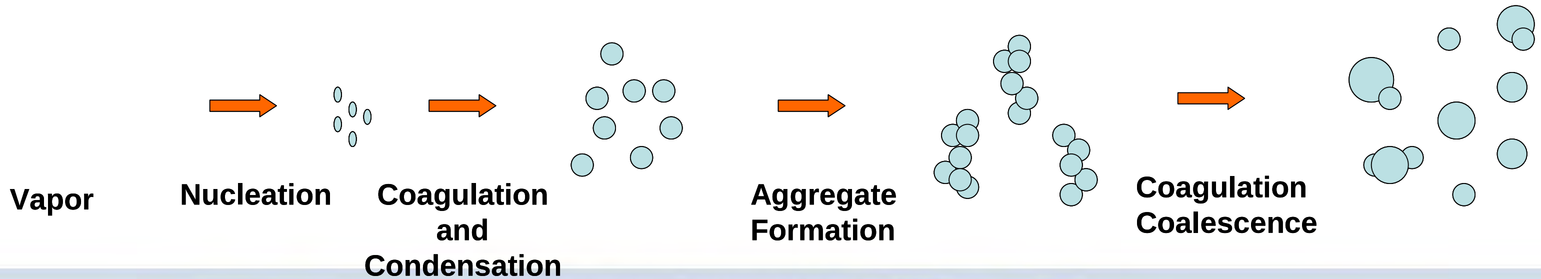
$$r_N = \frac{v_1}{\rho_g}\left[\frac{2\sigma}{\pi m_1}\right]^{\frac{1}{2}} n_{ms}^2 S \exp\left[\theta - \frac{4\theta^3}{27(\ln S)^2}\right] n^*$$

$$r_C = \left[n_m \rho_g \frac{u_m}{4} - n_{ms}\frac{u_m}{4}\right]\left[n_p \pi d_p^2\right] f(Kn)$$

$$r_F = 0.5\frac{\beta n_p^{\ 2} \rho_g}{W_s}$$

$$\frac{\partial n_p}{\partial t} = r_N - r_F$$

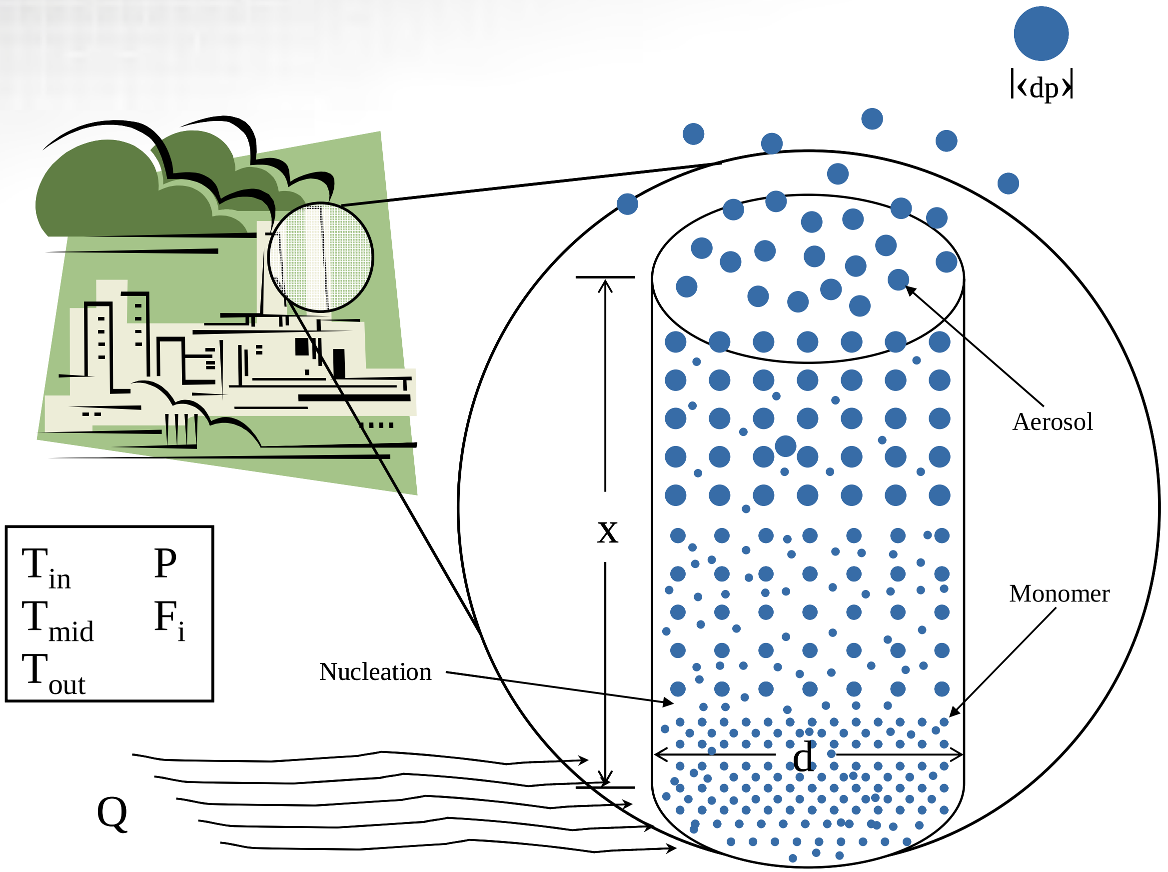
- **Change in number of monomer molecules…rate of formation of particles of interest**
- **Nucleation = *f*(supersaturation ratio, surface tension, etc.)**
- **Critical nucleus size = point at which particles are stable (Gibbs)**
- **Coagulation = *f*(Knudsen, supersaturation ratio, flow regime)**
- **Flocculation = *f*(Number of particles, Knudsen)**



Methodology:
Theoretical Model Assumptions/Limitations

- Single condensing component
- Ideal carrier density
- Neglects wall losses
- Produces an average particle diameter (monodisperse)
- Assumes no pair interaction potential between molecules during flocculation

The Stack Model



Methodology: Integration of STACK in EMIS

EMIS Output: process stream and thermodynamic information

↓

User selection of stack properties

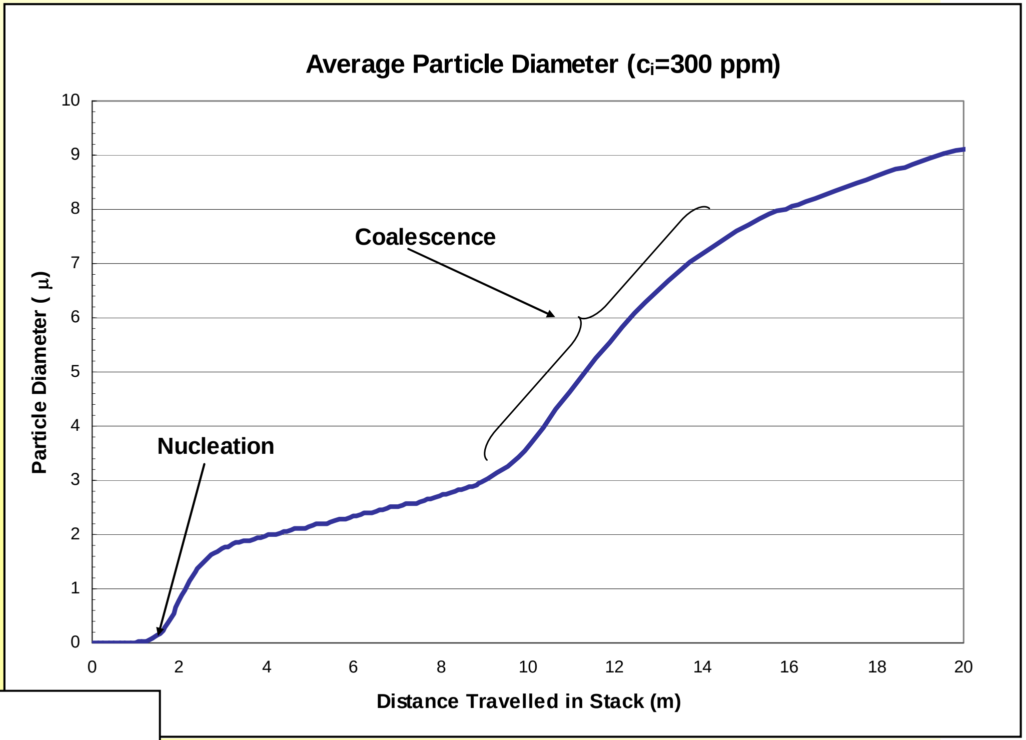
↓

Physical properties sort and comparison

↓

Compound for condensation is selected → **Physical property and stack data passed to STACK algorithm** → **LSODE run on model produces new n_m and d_p**

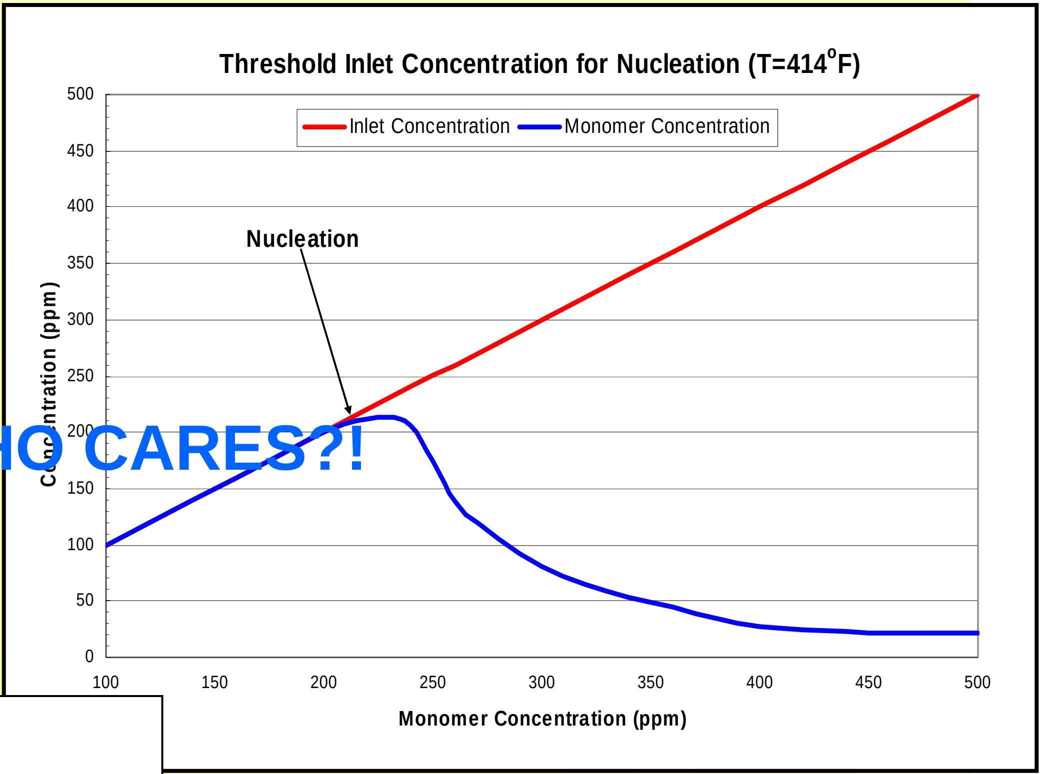
Results: TEPO Particle Size



Example: Parameters

- Compound: **TEPO (Triethyl Phosphate)**
- Carrier Gas: **Air**
- Boiling point: **419°F**
- Stack height: **20 m**
- Stack diameter: **0.3 m**
- Effluent Temperature: **404°F**
- Outlet Temperature: **350°F**

Results: Threshold Nucleation

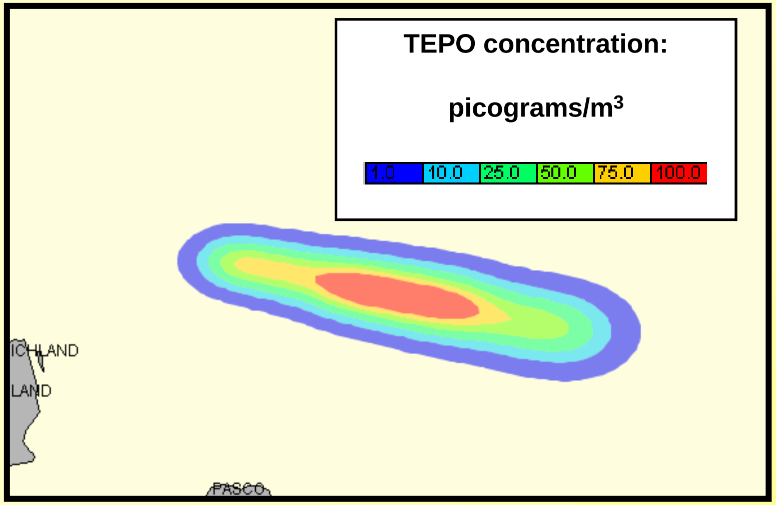


WHO CARES?!

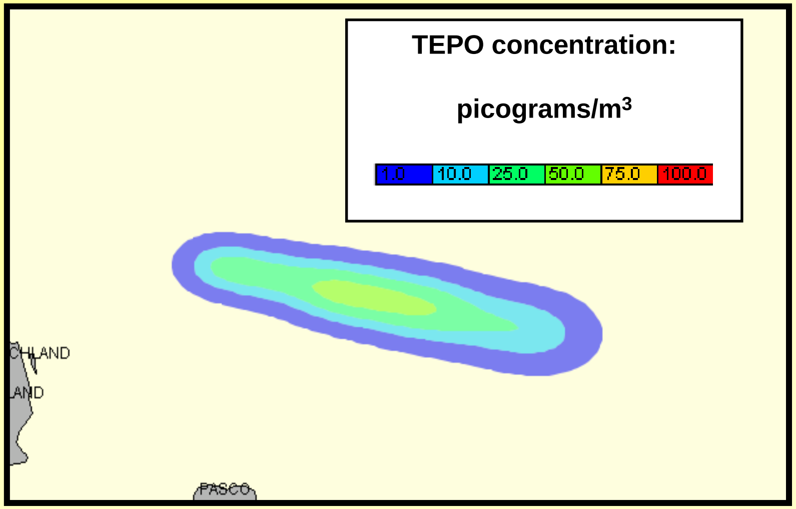
Example: Parameters

- Compound: **TEPO (Triethyl Phosphate)**
- Carrier Gas: **Air**
- Boiling point: **419°F**
- Stack height: **20 m**
- Stack diameter: **0.3 m**
- Temperature: **414°F**

Results: Example T&D Runs



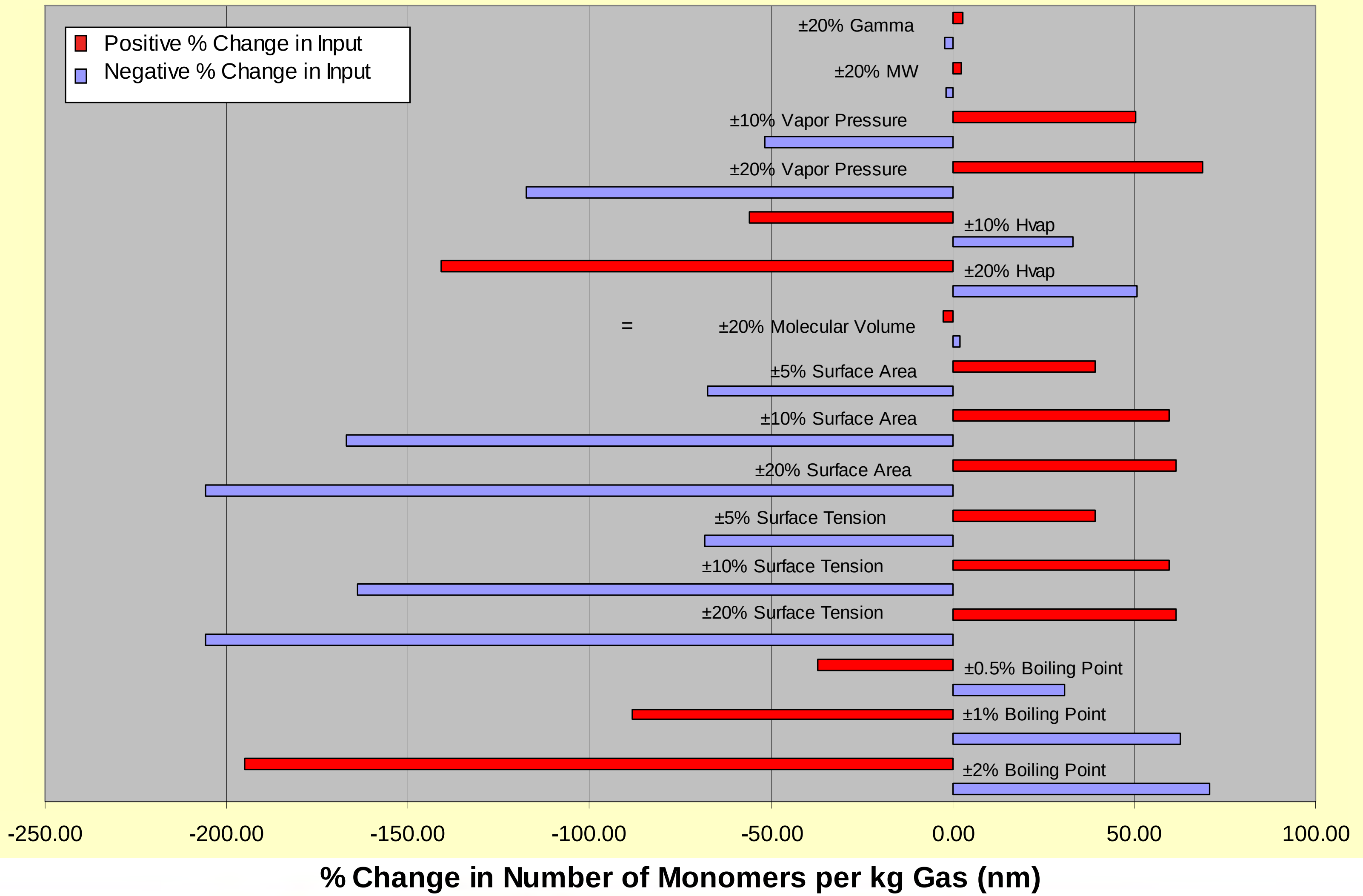
Gas Phase SLAM Run



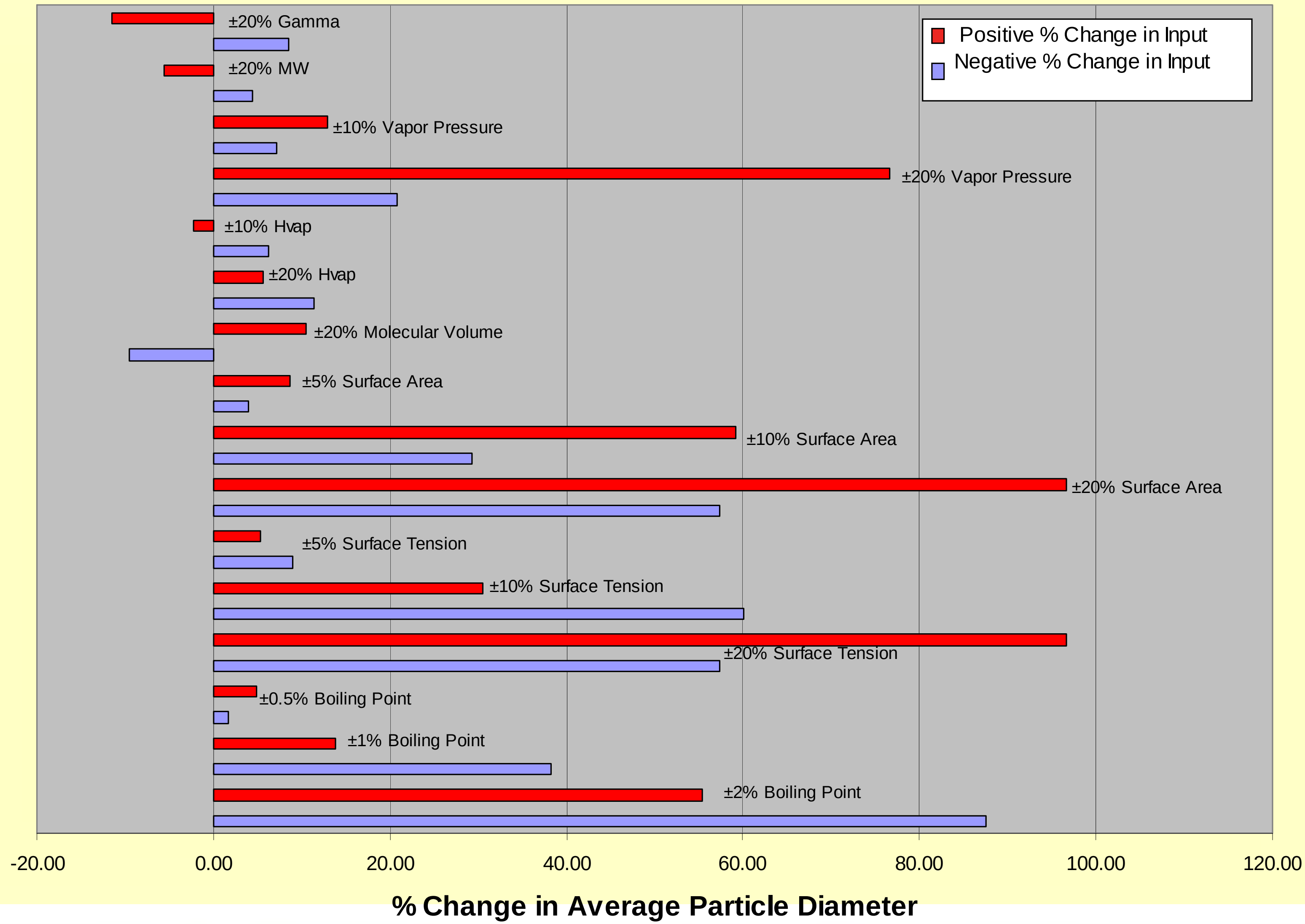
Particulate (d_p= 5μm) SLAM Run

8 hour release starting at noon local time: 1 kg/hr

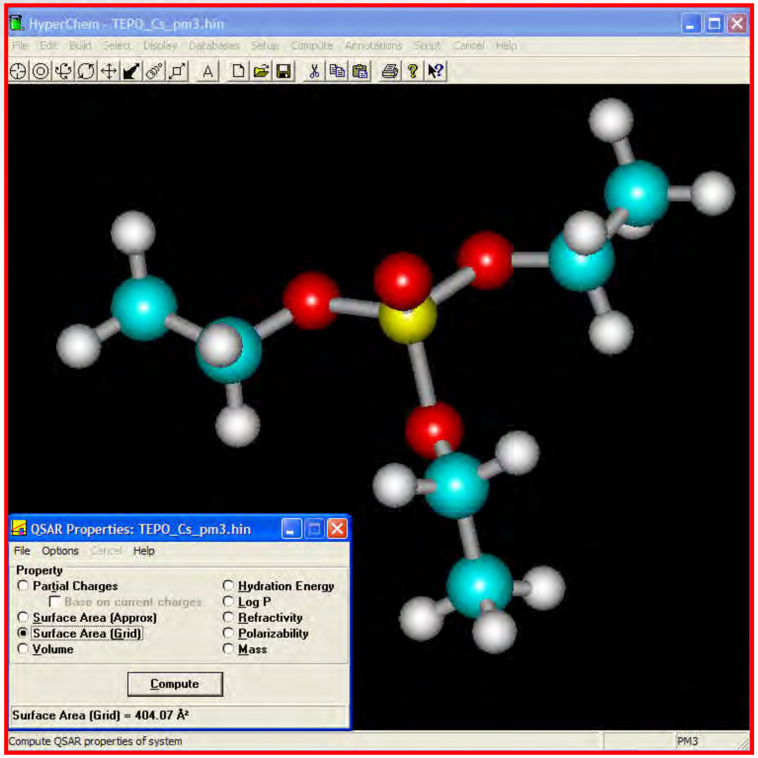
Model Sensitivity: Analysis, n_m



Model Sensitivity: Analysis, d_p

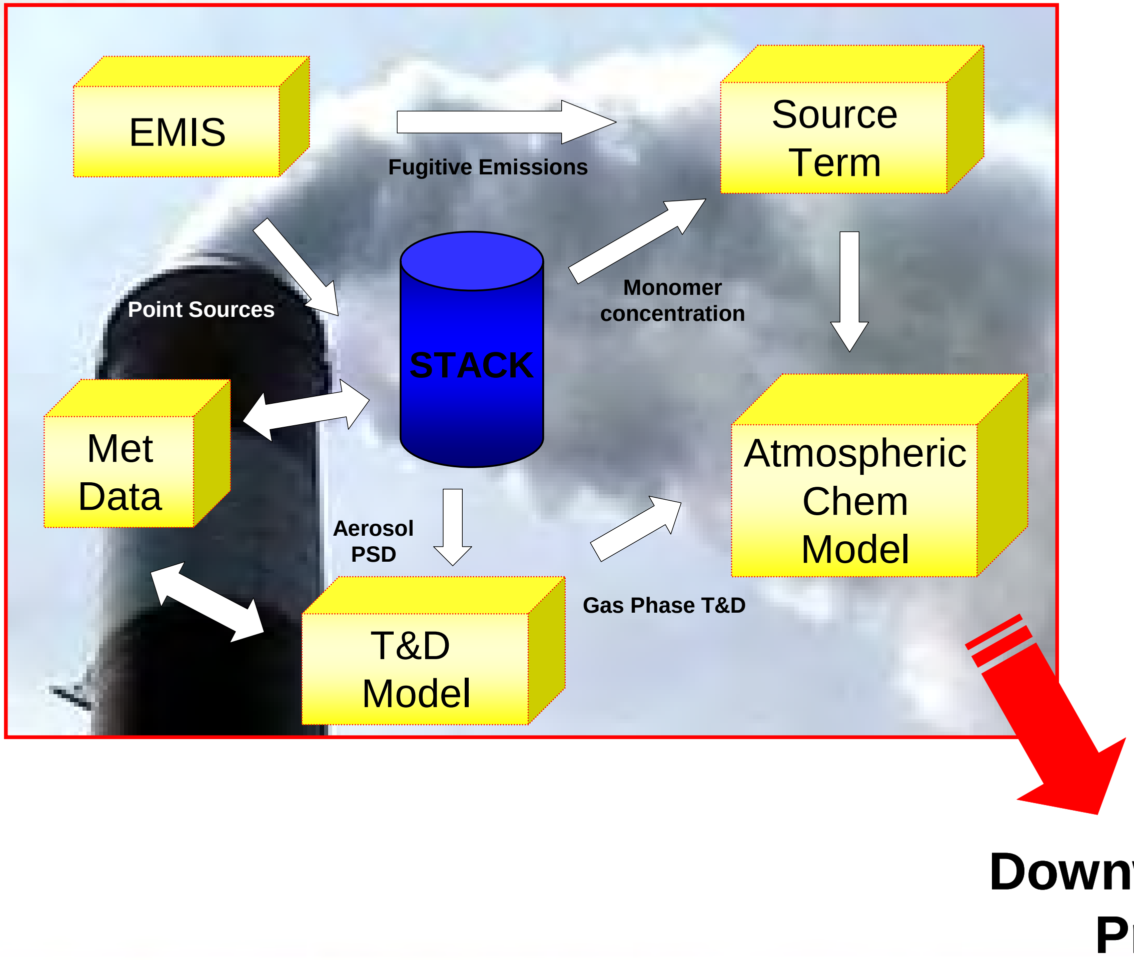


Model Sensitivity: Physical Property Estimation



- **Experimental and literature values**
- **ChemCAD physical property data and thermodynamic information**
- **Molecular surface area and volume estimated using molecular modeling tools (e.g. HyperChem, Gaussian)**
- **Physical property estimations (i.e., gamma from bulk stream viscosity)**
- **“SWAG”**

The Solution



Future Work

- **Incorporate particle size distribution**
- **Improve handling of multicomponent effects**
- **Model verification and validation**
  - Literature
  - Field study data
  - Experimental data
- **Incorporate mixing effects outside the STACK**
  - Plume rise
  - CFD modeling

Questions?

Welcome

Dynamic Multi Sensor Management System

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Introduction

A Sensor Performance Data Management System is proposed to account for interaction of static and dynamic aspects of sensor performance.

This will support Battlespace Management of sensor networks by providing information of sensor performance at specific locations and times within an area of interest.

Introduction

A Sensor Performance Data Management System is proposed to:

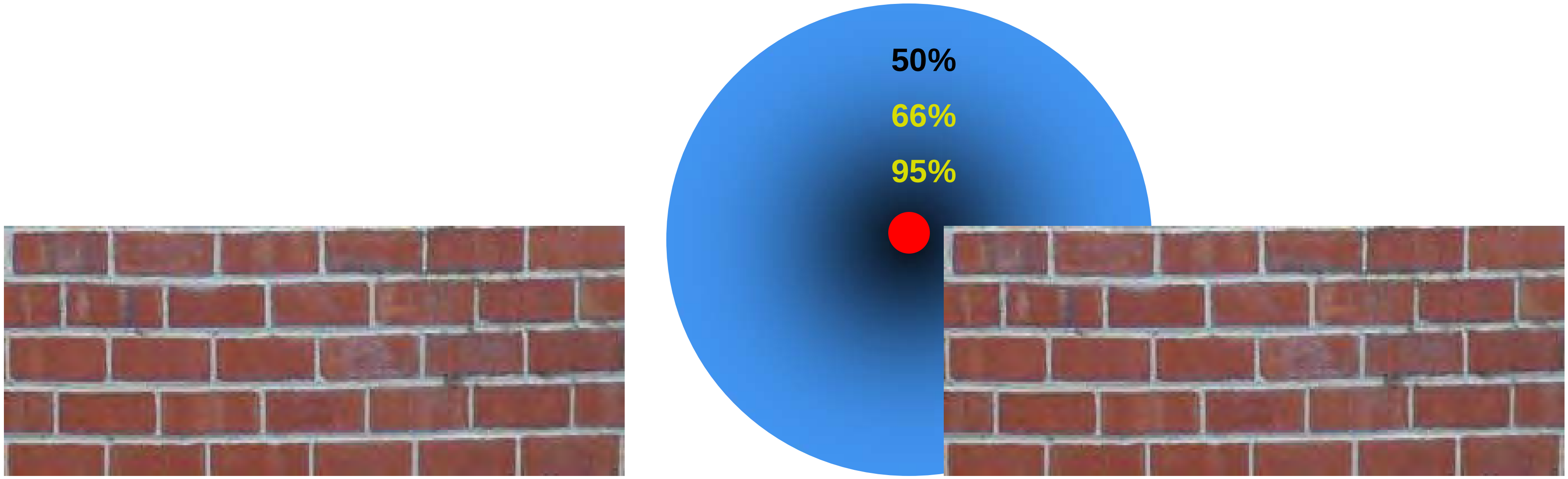
account for interaction of static and dynamic aspects of sensor performance.

This will support Battlespace Management of sensor networks by providing information of sensor performance at specific locations and times within an area of interest.

Multi Sensor Network To Protect Entry Gate

Each Sensor has a limited field of regard

Each Sensor has it's own unique performance contour

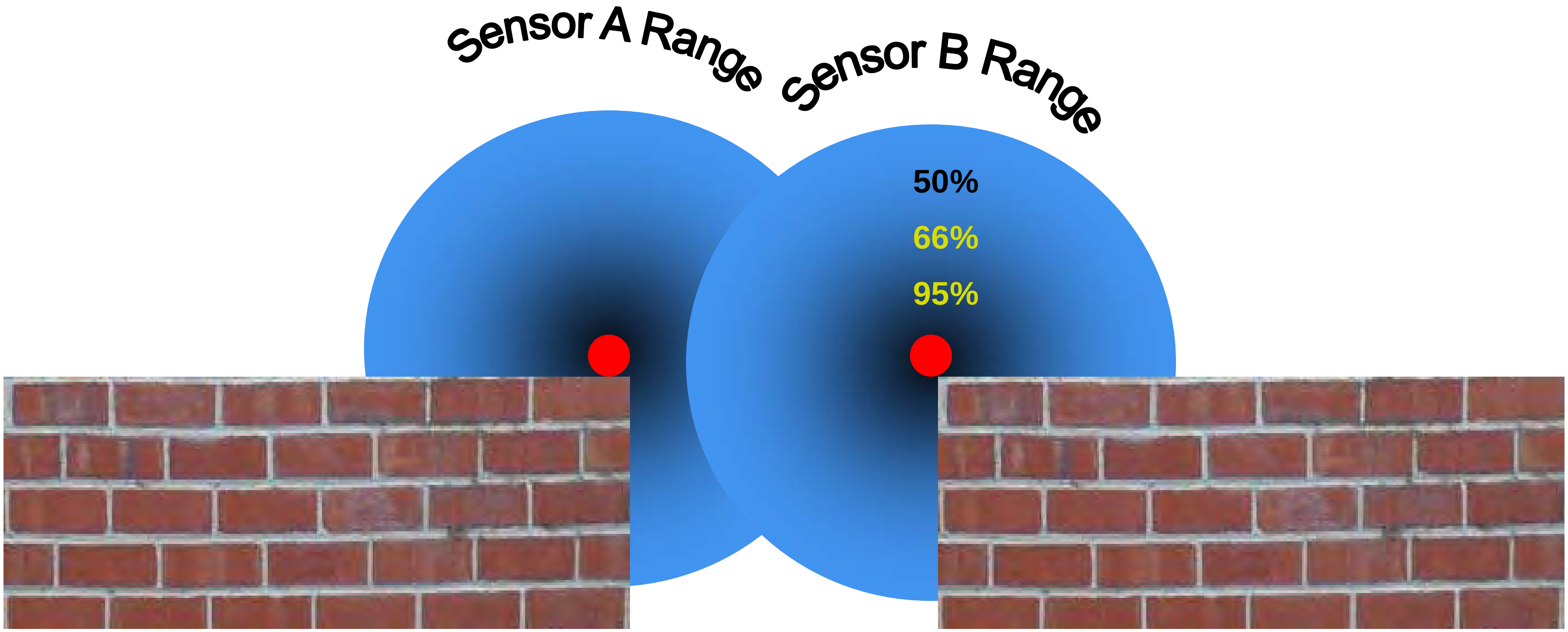


Chemical Sensor

Multi Sensor Network To Protect Entry Gate

Each Sensor has a limited field of regard

Each Sensor has it's own unique performance contour



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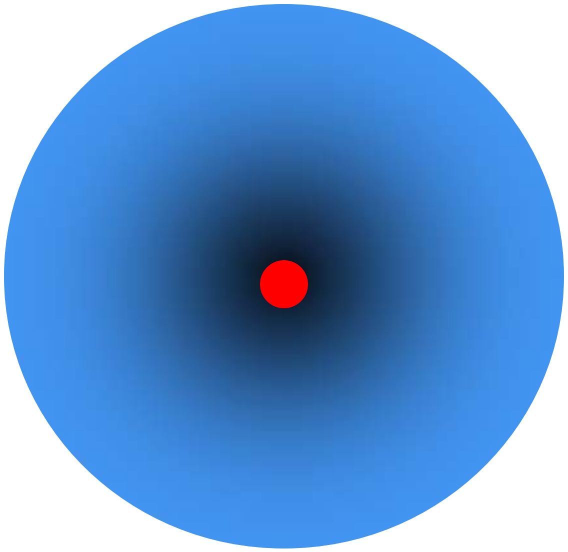
Performance Modeling Today

- Performance Modeling (PM) is often a single prediction as though sensor performance is uniform over an entire field of regard assuming
  - Worst Case
  - Average Case
  - Best Case



Issues

- Sensor performance is inherently a spatially AND temporally variant quantity
  - A single performance prediction may be good ‘on average’, but poor at any particular location or time
  - What happens when a sensor is not operating within design limits?

Variables Effecting Sensor Performance

- **Environmental Issues**
  - Wind
  - Humidity
  - Lighting
  - Temperature
- **Sensor Issues**
  - Calibration state
  - Sensor health

Decision Maker Assumes Standard Operating Environmental Conditions

Data Flow

Sensor Network

Sensor Data

Metadata

Data Reduction & Fusion

Decision Maker

Alarm

No Alarm

Assumes standard conditions:

1. Environmental

2. Sensor State

The decisions are based on standardized operating conditions (nominal)

Actual Environmental Conditions

Data Flow

Sensor Network

Sensor Data

Metadata

Data Reduction & Fusion

Decision Maker

Alarm

No Alarm

As standardized operating conditions vary, assumptions about sensor performance will change

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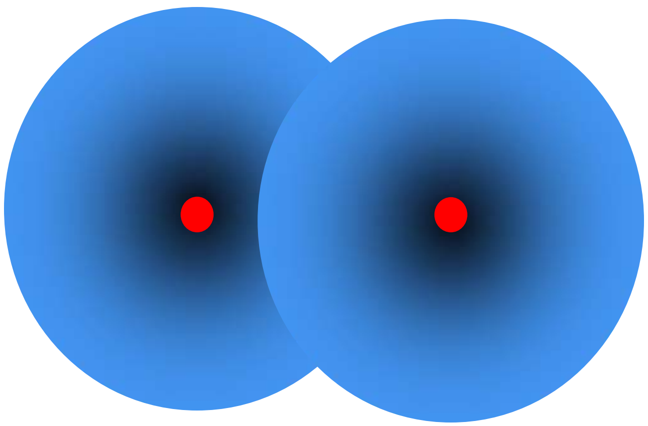
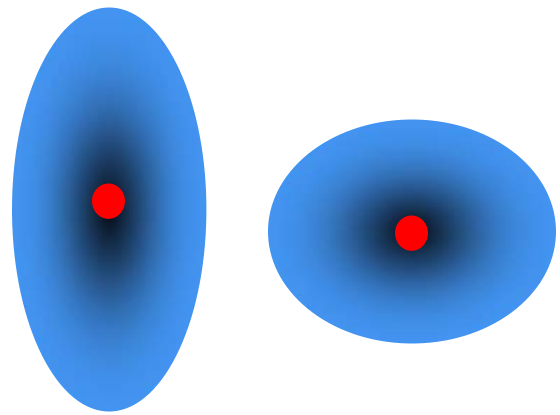
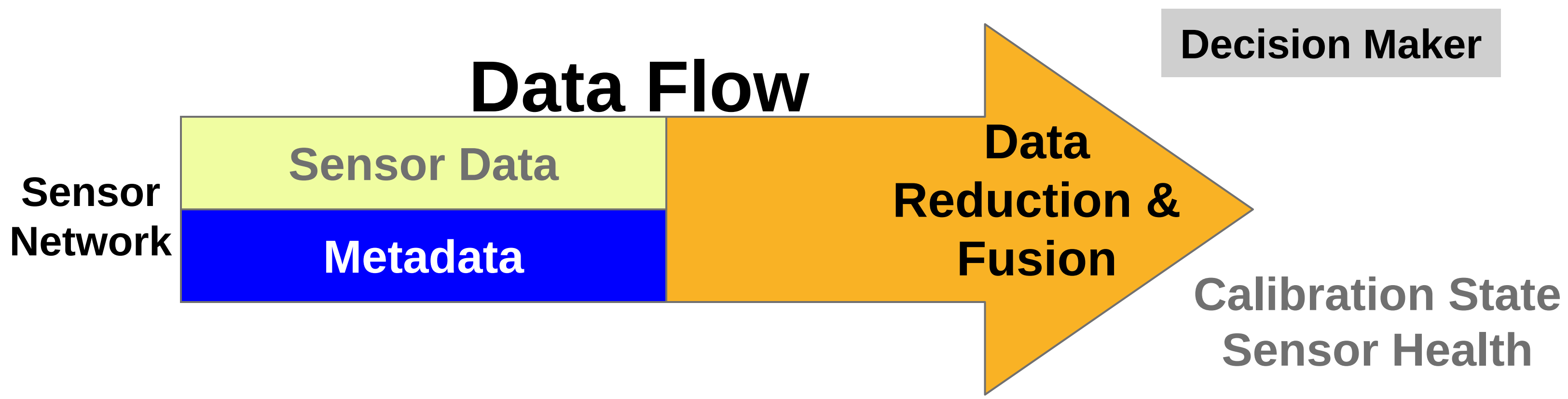
Sensor Coverage: Environmental Differences





Sensor Operating Performance & Area Coverage

Sensor State Conditions



The decisions are based on standardized operating conditions (nominal)

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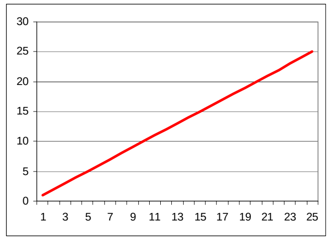
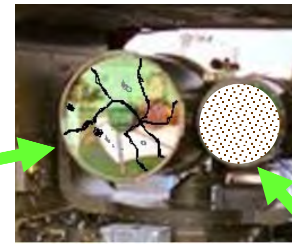
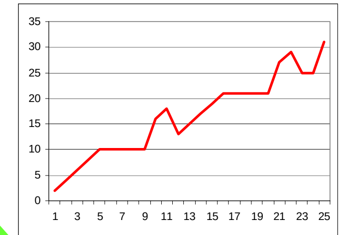
Sensor State Coverage

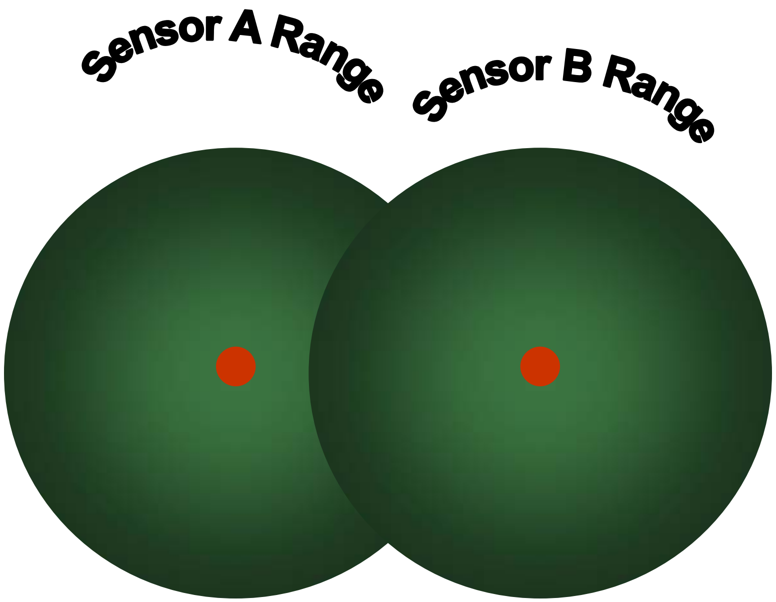


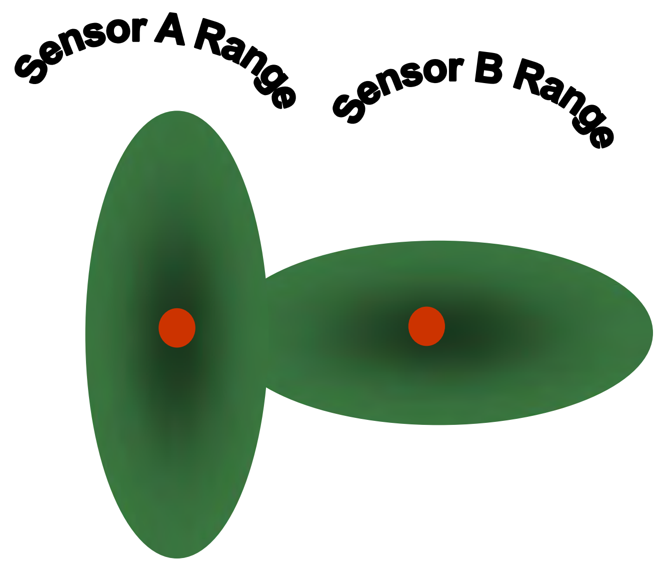
Lens cracks



Dirty Window

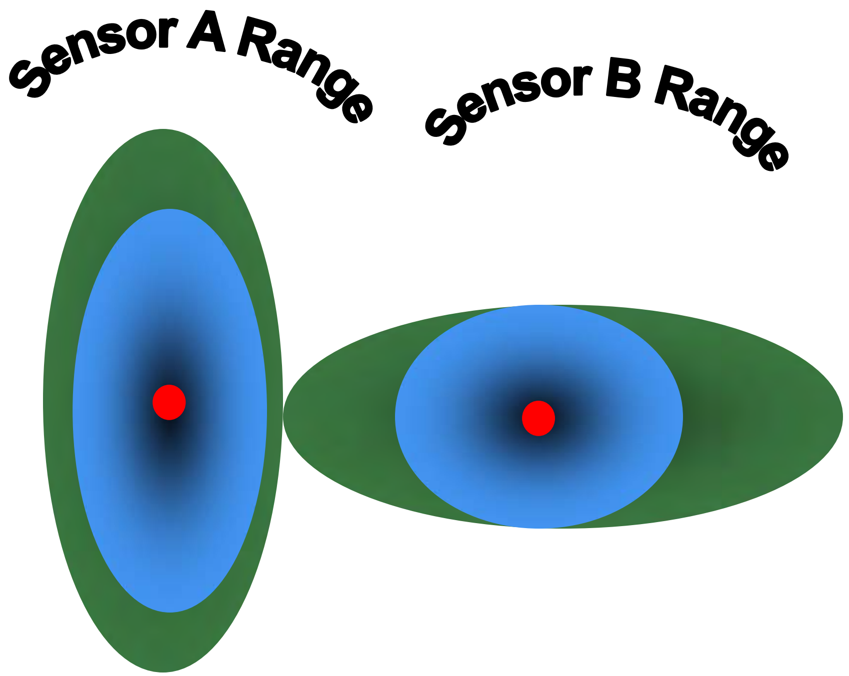




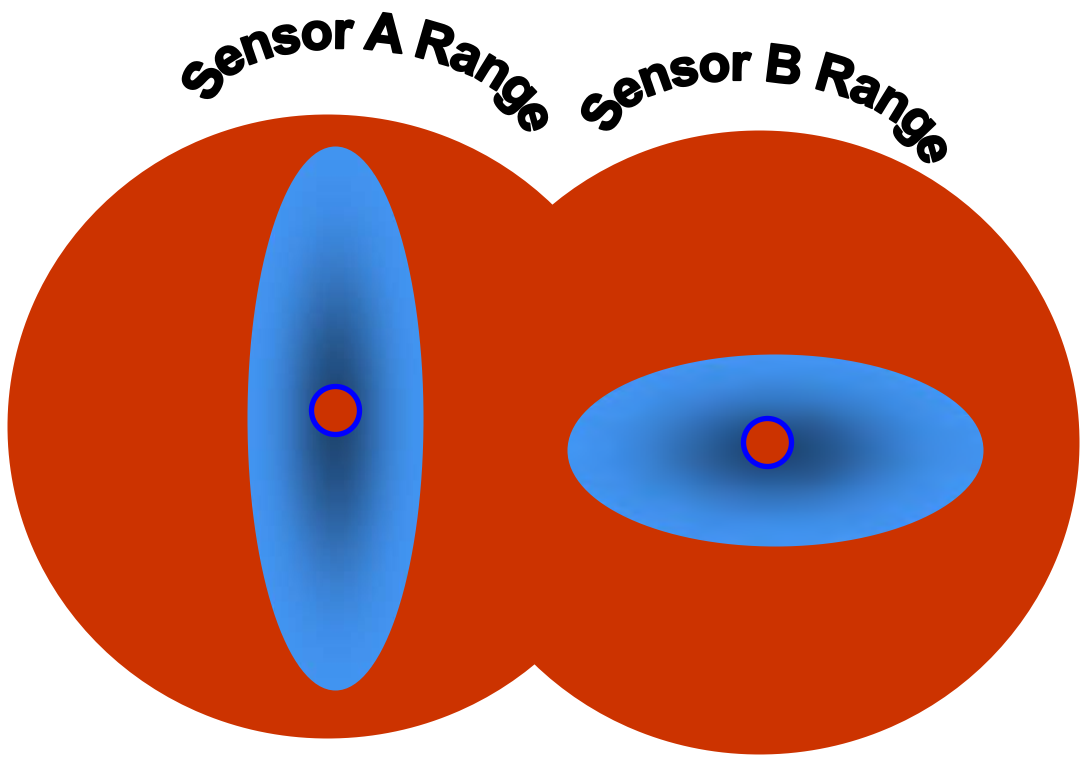


Sensor State Operating Performance & Area Coverage

Combination of Environmental and Sensor State Contours



Sensor Area Coverage Lost from Nominal Conditions



= Sensor area coverage lost due to Environmental & Sensor State Restraints

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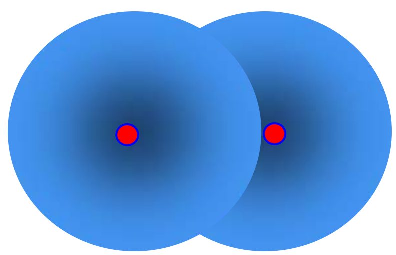
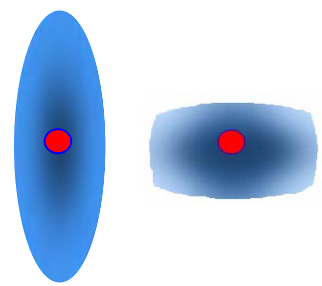
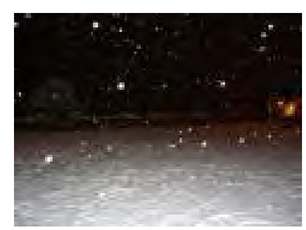
Solution: A Picture of Sensor Performance

Manage Sensor performance actively during operations of each sensor

Update as a function of location and time within the sensor field of regard







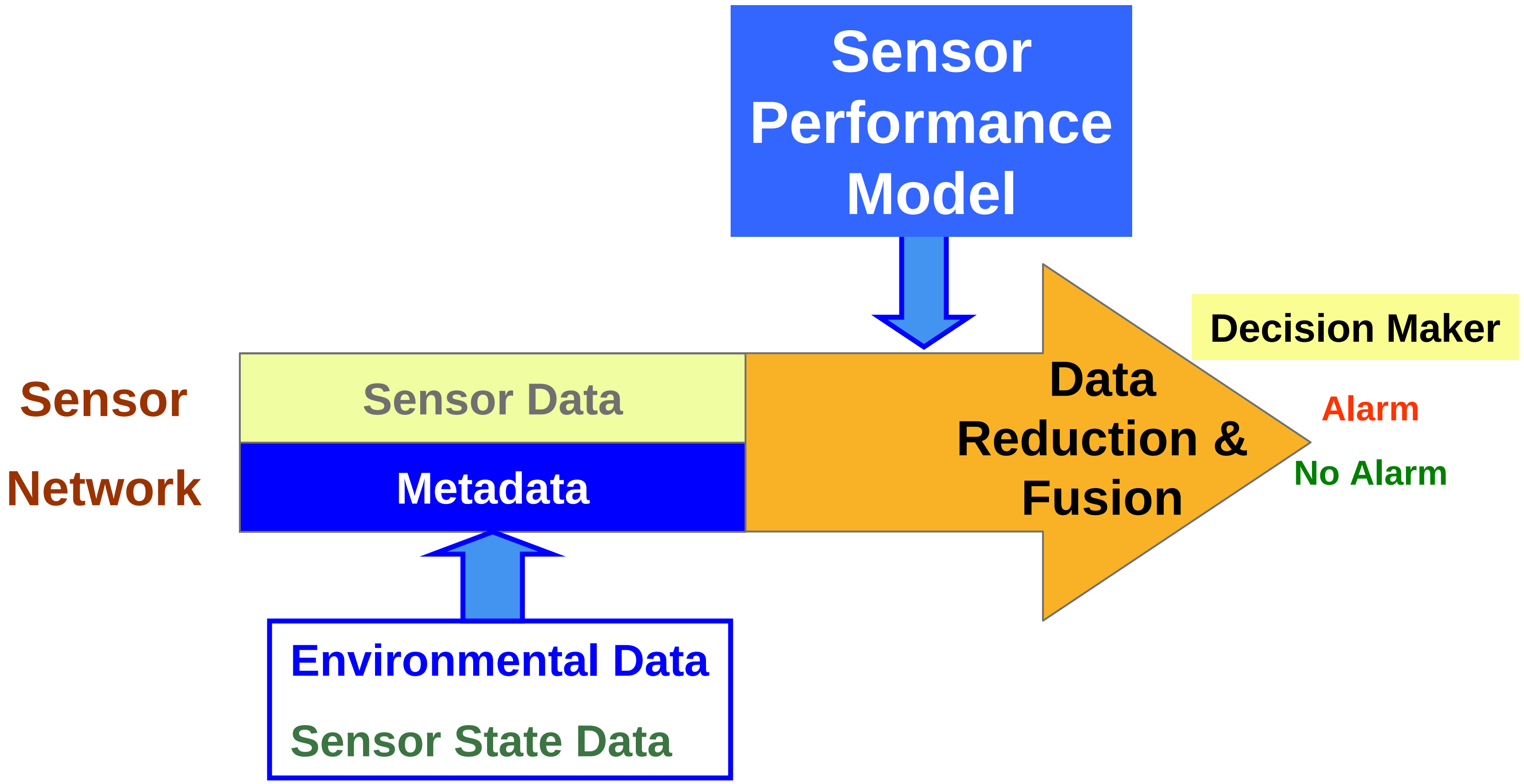
Sensor Performance Models

Sensor Performance Models are commonly used in sensor development and testing.

Examples:

- Chemical and Gas Sensing models include plume migration and wind effects as well as other important factors
- Imaging Sensor Models account for exposure, focus and atmospherics as well as other important factors

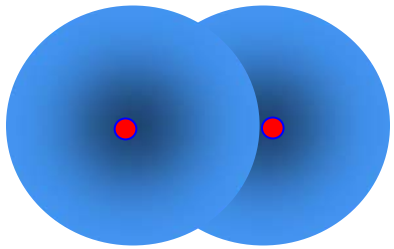
Solution: Insert Sensor Performance Model



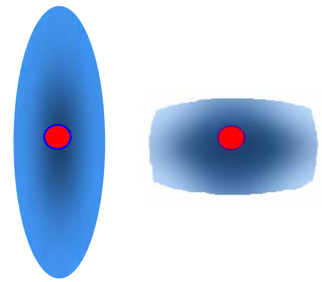
Insert Sensor Performance Model into operational architecture

Solution: Insert Sensor Performance Model

Is it this



Or this?



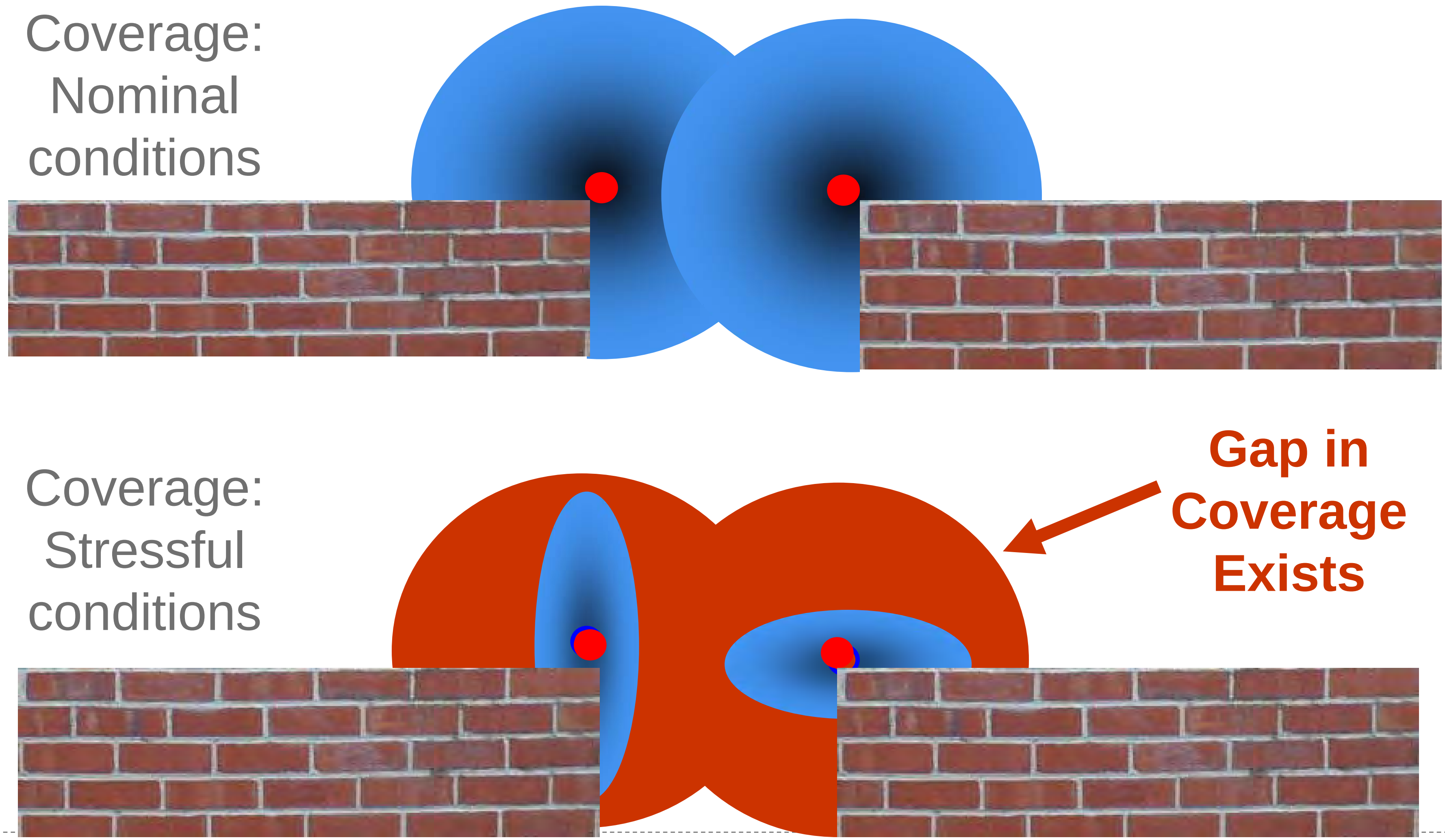
Sensor Performance Model

Evaluate Predictions Against Requirements

Confirm coverage **Or** Identify gaps

Decision Maker

Predictions Evaluated Against Requirement



Near Real Time Threat Mitigation

Identify coverage gaps due to

- Changes in Environmental conditions
- Failed/degraded sensors

Answer the following questions

- Where coverage gaps?
- How big are they?
- Can I redeploy existing sensors to remove/reduce the gap?
- Where do I deploy additional sensors to fill gaps?

Threat Management Applications

Supports re-assessment of network capability during operations

Provides capability to assess performance against stressful operational scenarios

Allows Redesign of operational sensor networks

- New mission requirements
- Variable threat levels
- New/improved sensor technologies

Conclusion

Integration of the Sensor Performance Model into your operational sensor network will provide dynamic knowledge of the system performance at particular locations and times within an area of interest.

This benefits battlespace management by supporting:

Near Real Time Threat Mitigation

Threat Management Applications

ITT Sensor Performance Modeling Experience

Sensor Type	Application
Thermal	Night time and low light Target Detection and identification
Video	Target detection, identification and tracking
Multi-Spectral	Materials Detection and Identification, full color and false color imaging
Hyper-Spectral	Material and Chemical Agent Detection and identification.
IMS	Chemical Gas Detection
LIDAR	Solid and Gas Biological and Chemical Agent Detection

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Realizing the Promise of NBC Battlespace Management

Focusing on non-material solutions

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Overview

- ❑ **The relationship between the ACTD technology and operational intergration**
  - •Material Solution
  - •Non-Material Solutions
- ❑ **Challenge of Integrating Technology**
- ❑ **A process for integrating technology into an operational environment**
- ❑ **Automating the integration process**

The CBRNE Threat

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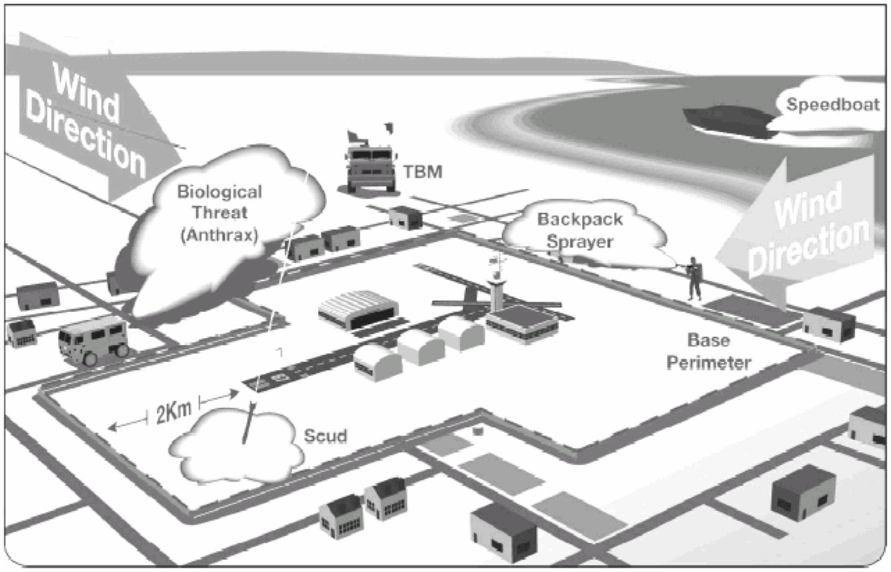
Fixed sites in the rear area will likely be targeted with persistent chemical agents and point- or line-source- delivered biological agents, in addition to the possible use of radiological dispersal weapons. 3-11.44



Types of Attacks

- Special Forces
- Air
- Missile
- Terrorist
- Collateral Damage from counterforce strike
- Industrial release
- TICs/TIMs

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Info Technology Objectives

Develop a common operational picture concerning base chemical and biological attack status and related situational awareness information by integrating and exploiting disparate data sources.

Provide situational display on a common user system that gives the Commander an overall defense picture of the port, such as contamination, fires, locations of unexploded ordinance, battle damage assessment, etc.

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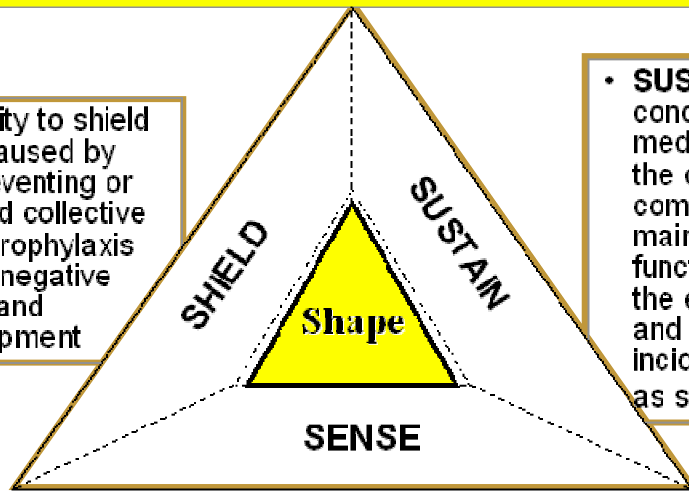
The S – Elements: CBRN Defense

- **SHAPE –** Provides the ability to characterize the CBRN hazard to the force commander - develop a clear understanding of the current and predicted CBRN situation; collect, query, and assimilate info from sensors, intelligence, medical, etc., in near real time to inform personnel, provide actual and potential impacts of CBRN hazards; envision critical SENSE, SHIELD and SUSTAIN end states (preparation for operations); visualize the sequence of events that moves the force from its current state to those end states.

- **SHIELD –** The capability to shield the force from harm caused by CBRN hazards by preventing or reducing individual and collective exposures, applying prophylaxis to prevent or mitigate negative physiological effects, and protecting critical equipment



- **SUSTAIN –** The ability to conduct decontamination and medical actions that enable the quick restoration of combat power, maintain/recover essential functions that are free from the effects of CBRN hazards, and facilitate the return to pre-incident operational capability as soon as possible.

- **SENSE –** The capability to continually provide the information about the CBRN situation at a time and place by detecting, identifying, and quantifying CBRN hazards in air, water, on land, on personnel, equipment or facilities. This capability includes detecting, identifying, and quantifying those CBRN hazards in all physical states (solid, liquid, gas).

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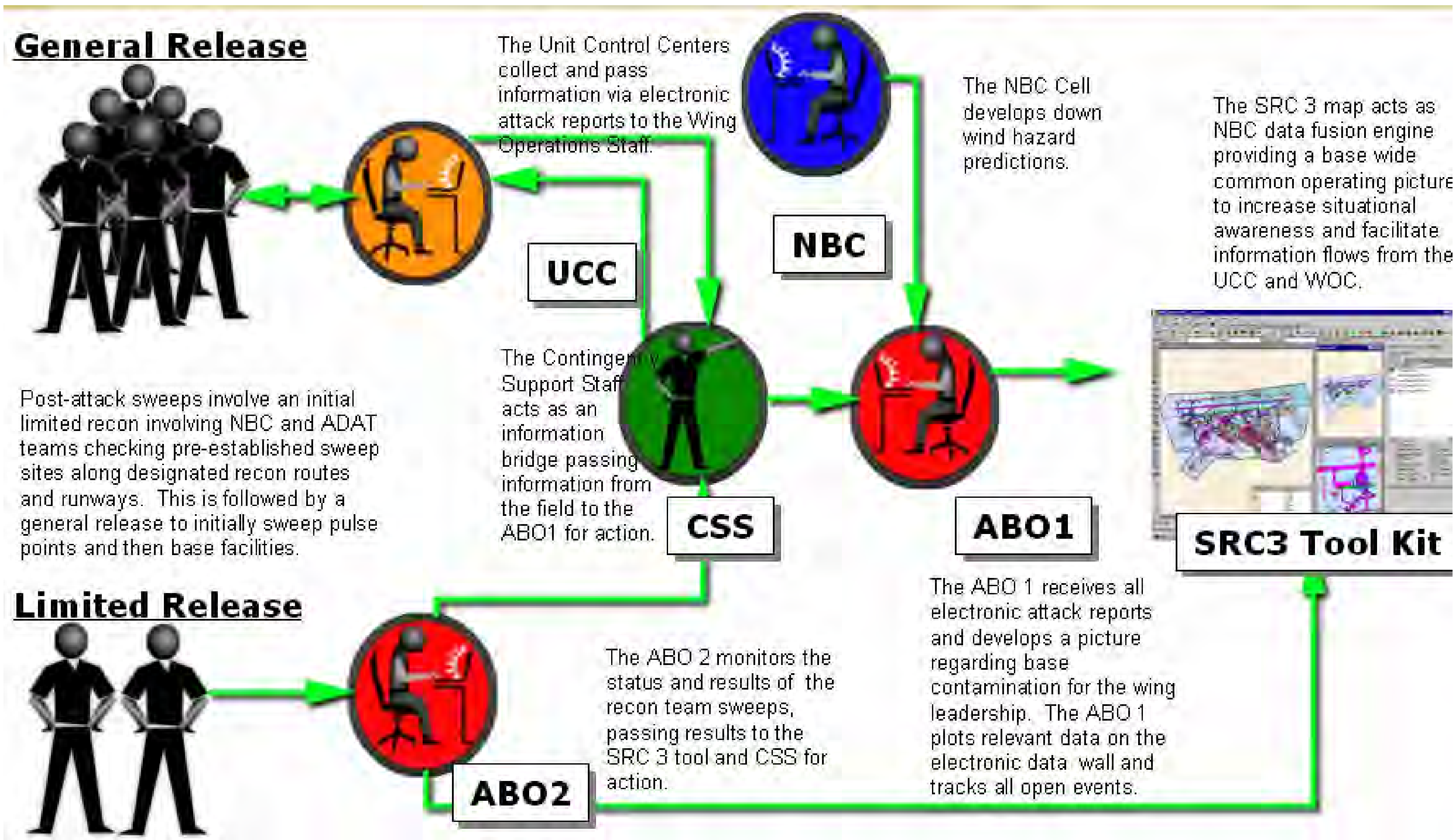
Work Flow



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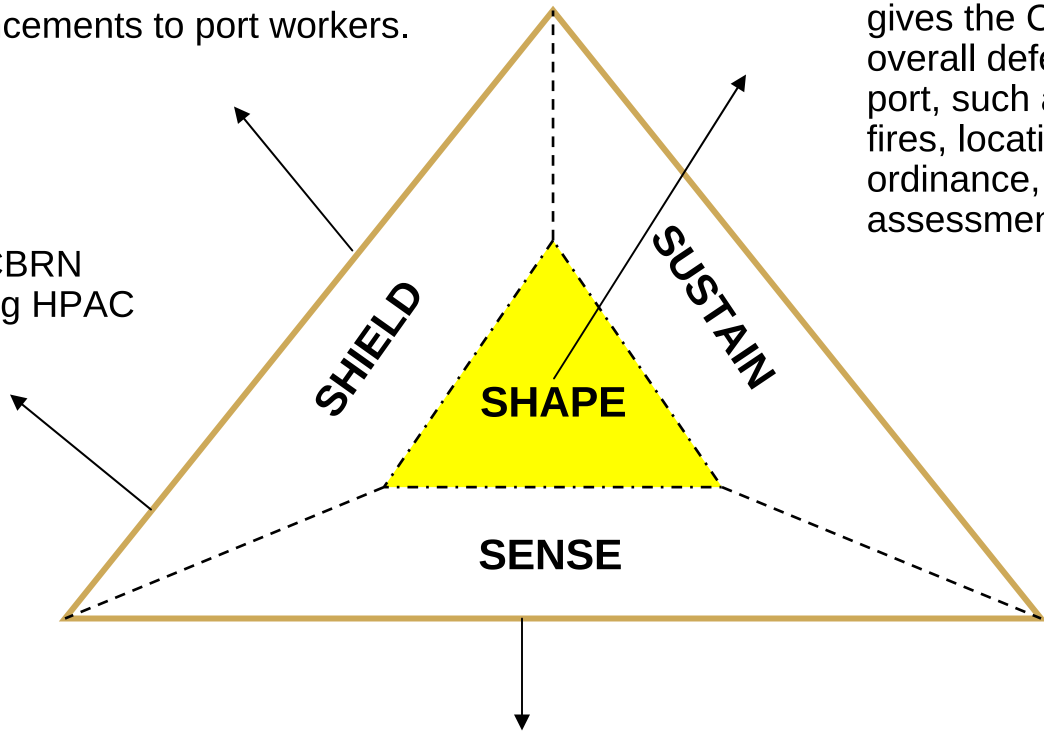
ACTD Solution in Support of the S Elements

- **Audio/Visual Port Warning (Giant Voice)** - Integrated alert and warning system not reliant on local power grid, providing repetitive visual and audible warning announcements to port workers.

- **Situational Awareness** - Provide situational display on a common user system that gives the Commander an overall defense picture of the port, such as contamination, fires, locations of unexploded ordinance, battle damage assessment, etc.

- **Hazard Modeling -** CBRN hazard modeling using HPAC



- **Networked Detectors** - Identify a networked system of detectors that can detect to warn SPOD command center, as well as USCENTCOM and USTRANSCOM Joint Operations Centers.

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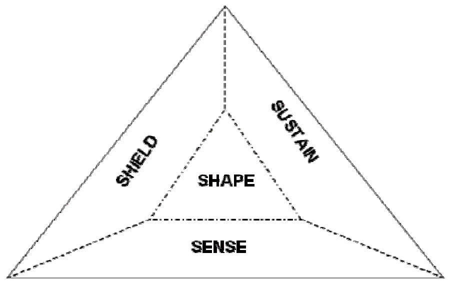
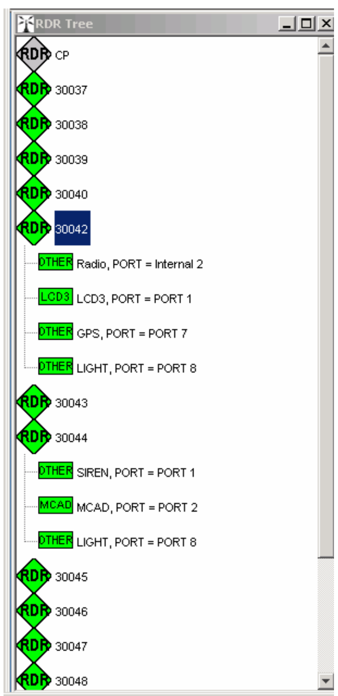
SA Tools: Sense



Sensor Network



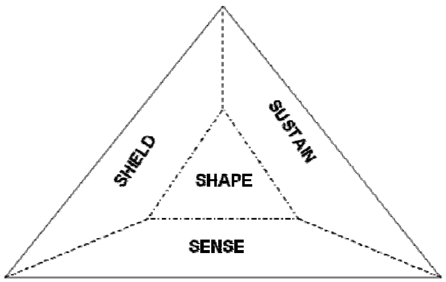
Description: The ACTD Solution system enables users to network an array of sensors into a incident command post. This functionality is pivotal in providing sensor input into the CB situational awareness picture and communicating alert and protective status messages.

Components: The system is built around the Remote Data Relay (RDR) radio frequency nodes and the sensor tree view in SA tools. The system supports the following

•chemical agent point detectors

•WX detectors

•GPS detectors




Directional and Omni directional Sirens


Lights indicting MOPP level


MOPP Signs

Warning Network: Components

System Overview: ACTD solution can be comprised of directional and omni-directional sirens operating at sufficient dbs to overcome ambient background noise. In addition, warning lights and signs are available to communicate protective levels. This capability satisfies the overall objective of providing visual and audio warning from the CPOC. The SA application provides the port commander with the ability to perform command, control, and communications across the installation for force protection, CB defense and transportation operations.

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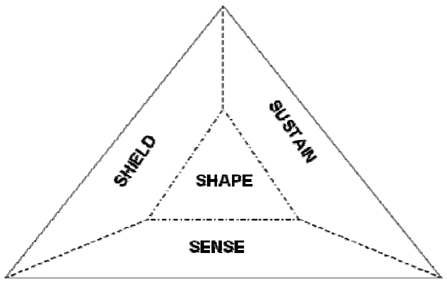
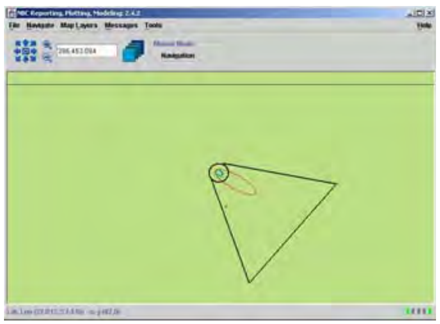
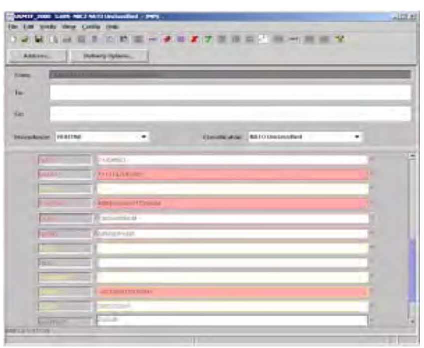
SA Tools: Sense & Shield







Modeling: Reporting Plotting Mapping

Description: The integration of the Defense Threat Reduction Agency Nuclear, Biological and Chemical Reporting, Plotting, Modeling (NBC_RPM) with the underlying database and map allows for seamless downwind hazard prediction and NBC 2 and 4 messaging. The SA architecture allows the RPM to automatically ingest source term and weather data to produce a hazard plume and share the results with other applications in the system.

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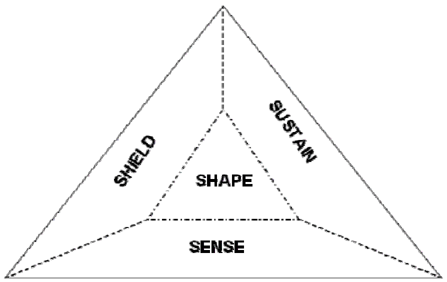
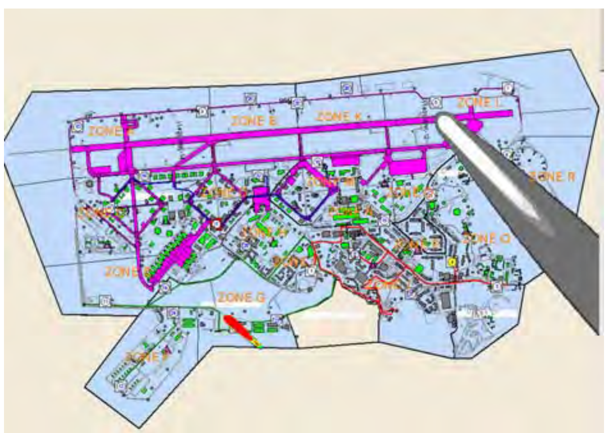
SA Tools: Shape



Data Fusion: Map Tool



Description: The SA tools collect a large volume of data that is then available for viewing in tabular and visual formats. The dissimilar nature of the event data collected during port recovery operations requires the ability to visualize the data to understand the geo-spatial relationships between events in the recovery process.

Components:
- •Sensor Tree
- •Incident Space AOR/AOI
- •Incident Effects (Wx & Terrain)
- •Event Reporting/Management
- •Modeling
- •Tailored Common Operational Picture

1. **Identify info requirements**
   1. Battlespace, MET, Unit locations, CBRN capabilities
   2. Enemy capabilities, likelihood of use

2. **Collect/Process Information**
   - Collect-info from attacks, reports, surveillance
   - Process- filter, format, compile, plot, evaluate
   - Store-retain for retrieval
   - Protect-ensure availability in information systems
   - Display-represent in audio/visual form for decision making
   - Disseminate-communicate evaluated info (NBC2/3/5)
   - Dispose-Record disposal.

3. **Build Common Operational Picture / Display**

4. **Develop Understanding to make decisions** (protection, avoidance and recovery)

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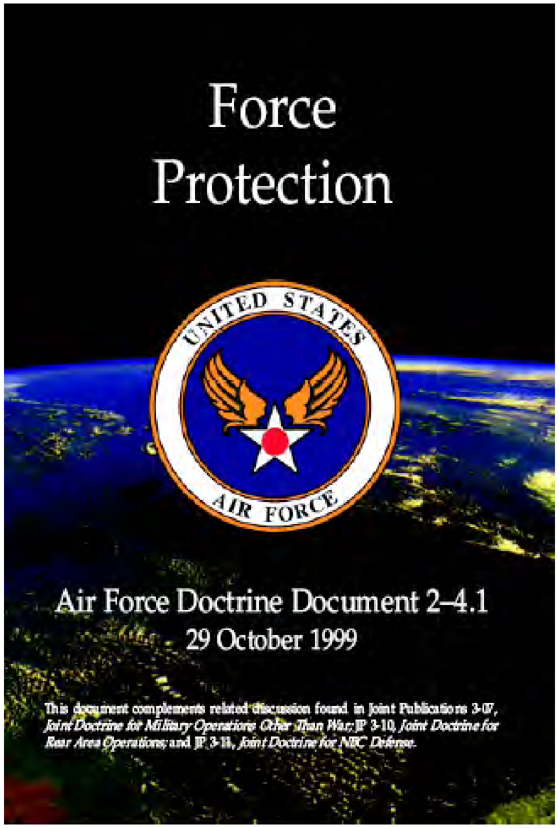
Fixed Installation Force Protection

- **Pre-Attack Contamination Avoidance**
  - Covering
  - Work Center Decontamination Stations
  - Contaminated Waste Disposal
- **Base Populace Response**
  - Aircraft
  - Missile
  - Ground Attack
- **Recognition of CW Droplet Fall Phase**

- **Use of Base Populace**
  - Detection
  - Reporting
  - Decontamination
- **Split MOPP Operations**
  - 19 Zones
  - Zone Transition Operations
- **MOPP Declarations**
  - Balance of Mission and Survivability
  - Reduction in MOPP After Detectors Read “Zero”



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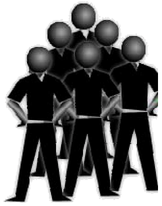
Enhanced Technical Capability

RF Network
- Sensors
- Warning Devices



Post Attack Sweeps
- NAI
- General

NBC Cell
- Modeling
- Reporting

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The Impact of Non-Material Factors : Training

The efficacy of the proffered material solution(s) is dependent on the ability of the receiving individual, unit, and organization to understand both the how and why the technology is intended to be used.

- "**Button Pushing" Training**
  - Adequate training and user proficiency
  - Supporting techniques and procedures for self sustaining proficiency
- **ConOps/Leadership Training**
  - Leadership understanding of underlying capability and applicability to their mission
  - Sufficient standard operating procedures and tactics for unit wide execution
  - Doctrinal permission to leverage technology breakthroughs

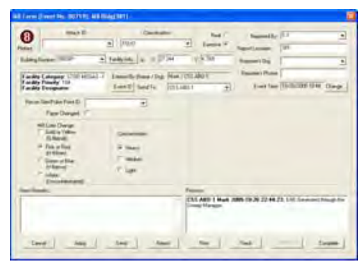
Information Management

Before ACTD

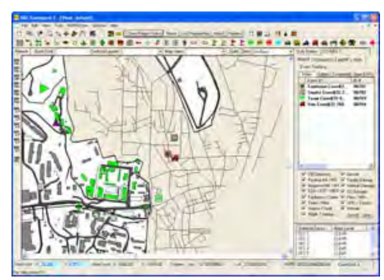
108 A Forms

Grease Pencil Map

ACTD



Electronic Attack Reports



Digital Display

Initial Impact

- Electrons & Grease Pencil Map Coexist
- EARs & 108s Coexist
- Ownership issues surround EARs
- Data Visualization

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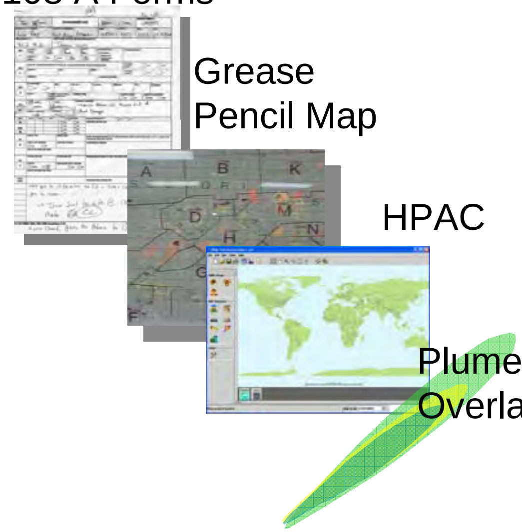
Hazard Modeling

Before ACTD

108 A Forms

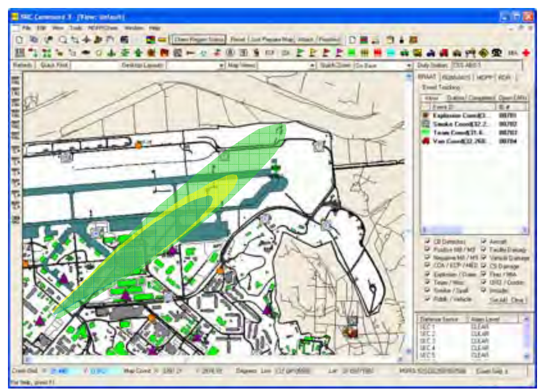


Grease
Pencil Map

HPAC

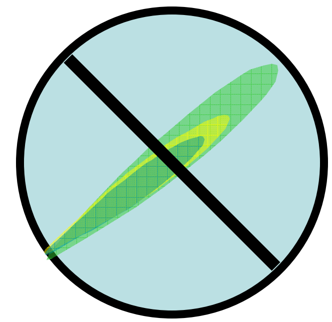
Plume
Overlay

ACTD



Integrated Modeling and Display

Initial Impact



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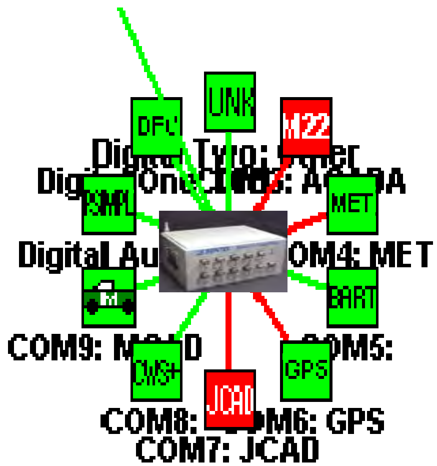
Sensor Networks

Before ACTD

Stand-alone Sensors

ACTD



Initial Impact

- •Sensor Placement
- •Sensor Alarm
- •Agent release confirmation
- •MOPP declaration
- •Sensor ownership

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NBC Surveys

Before ACTD

M8 Sweep

108 A Forms

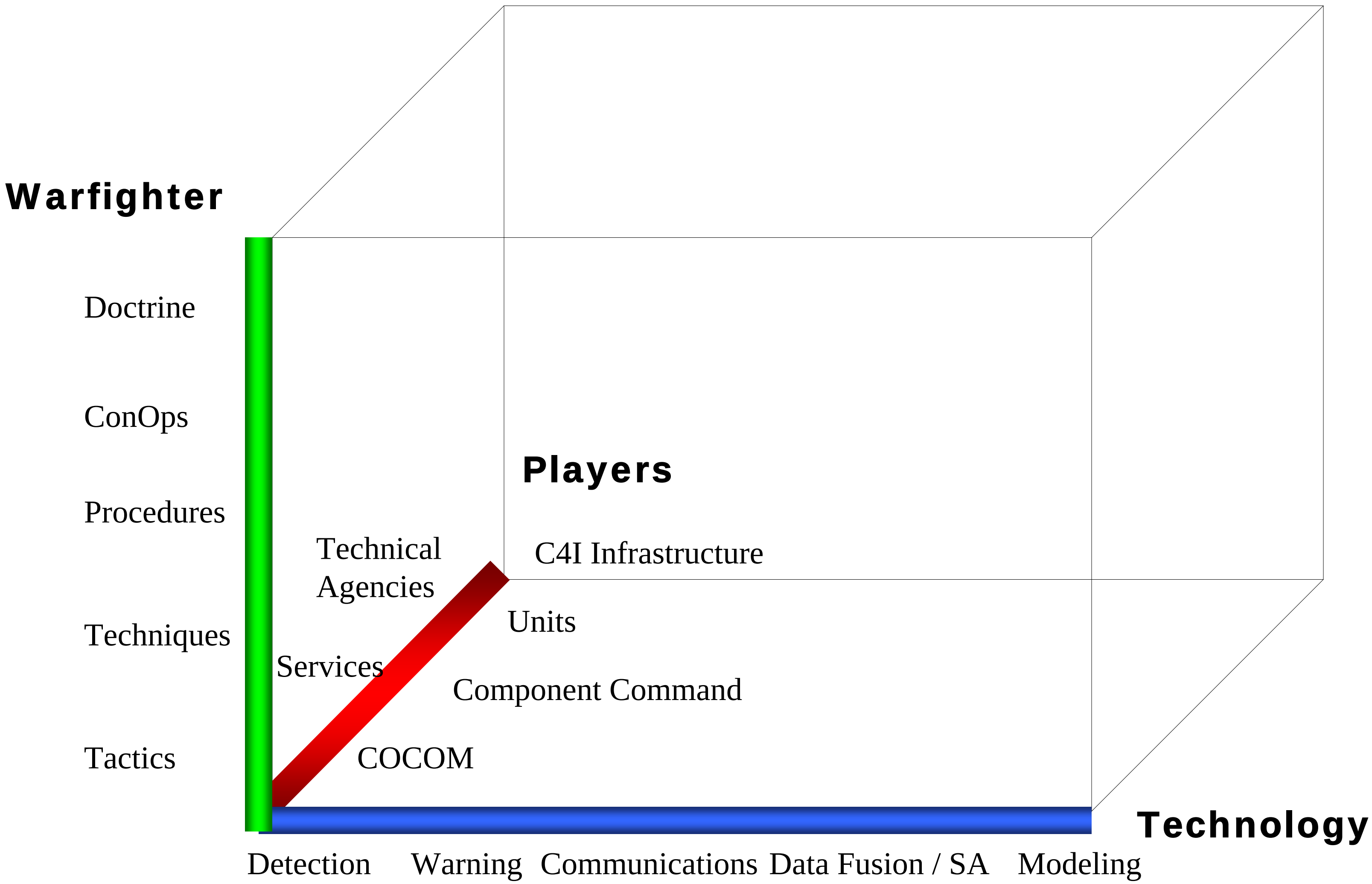
Grease
Pencil Map

ACTD

Initial Impact

- Sweep Implementation
- MOPP declaration

Problem Space



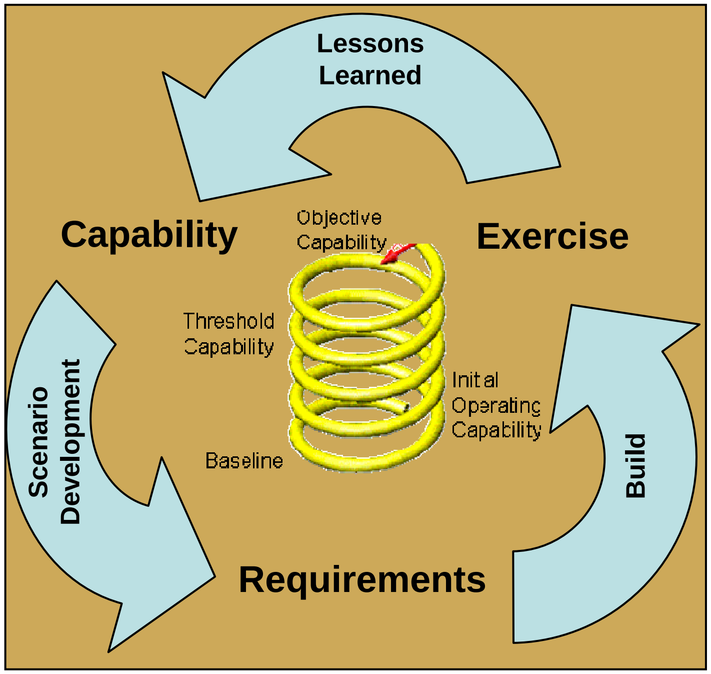
Integration Challenges

- **Maturity of the Material solution**
  - –Requirements Definition
  - –Graphic User Interface
  - –System Performance
- **Existing CBRNE Consequence Management Process**
  - –Defined SOPs
  - –NBC Staff
  - –Computer Capable Staff
- **Personnel Stability**
- **Competing Operational Concerns**
- **Unit Expectations**

- Develop a process that provides an in-depth understanding of a new capability before developing the formal operational requirements.

- Construct a initial operating capability that will determine system effectiveness, operability, and suitability before the requirements are formalized.

- **Assess the utility of a significant new capability and to conduct that assessment at a scale size adequate to clearly establish operational utility and system integrity.**



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Combat Evaluation Readiness Exercises

- Expert Threat and Vulnerability Assessments
- Modeling based hazards
- Detailed MSEL
- Live system injects from the field
- Live sensor triggers using simulants
- Developer Training
- Developer exercise support/observation

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Beyond ACTD

- **“Button pushing” Training**
  - Sensor Network
  - Warning Network

- **CONOPS/Leadership**
  - M8 Sweep Results
  - Message Flow
  - Sensor Network (Attack Declaration)

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Exercise/Training Objectives

Train the way you fight …

- Represent All Aspects of Material Solution (Sensors, M&S, Surveys, Event Reporting)
- Represent Realistic Threat Scenarios
- Provide Accurate Inputs

Feed inputs at a pace and sequence commensurate with real events and accordance with actual response timelines.

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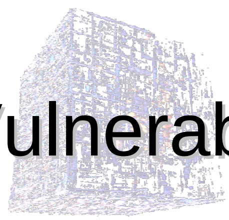
Making it Work

Turning Weapon Phenomenology into Consequences

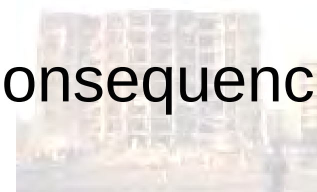

Threat + Vulnerability = Consequences

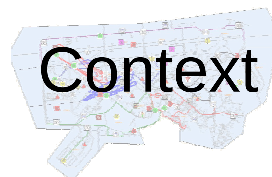
- Objective
- Agent
- Mechanism of Delivery
- Concept of Employment

- Assets
- Infrastructure
- NAI
- Sensor Arrays
- Recon Points

- Blast Damage
- Agent Deposition
- Agent Concentration
- Agent Dose
- Attack Info

Turning Consequences into Understanding





Consequences + Context = Understanding

- Blast Damage
- Agent Deposition
- Agent Concentration
- Agent Dose
- Attack Info

- Base ConOps
- Base Data
- Base SA Tool

- Sensor Readings
- Recon Results
- Medical (WIA & KIA)
- Facility Damage
- Cratering
- UXO

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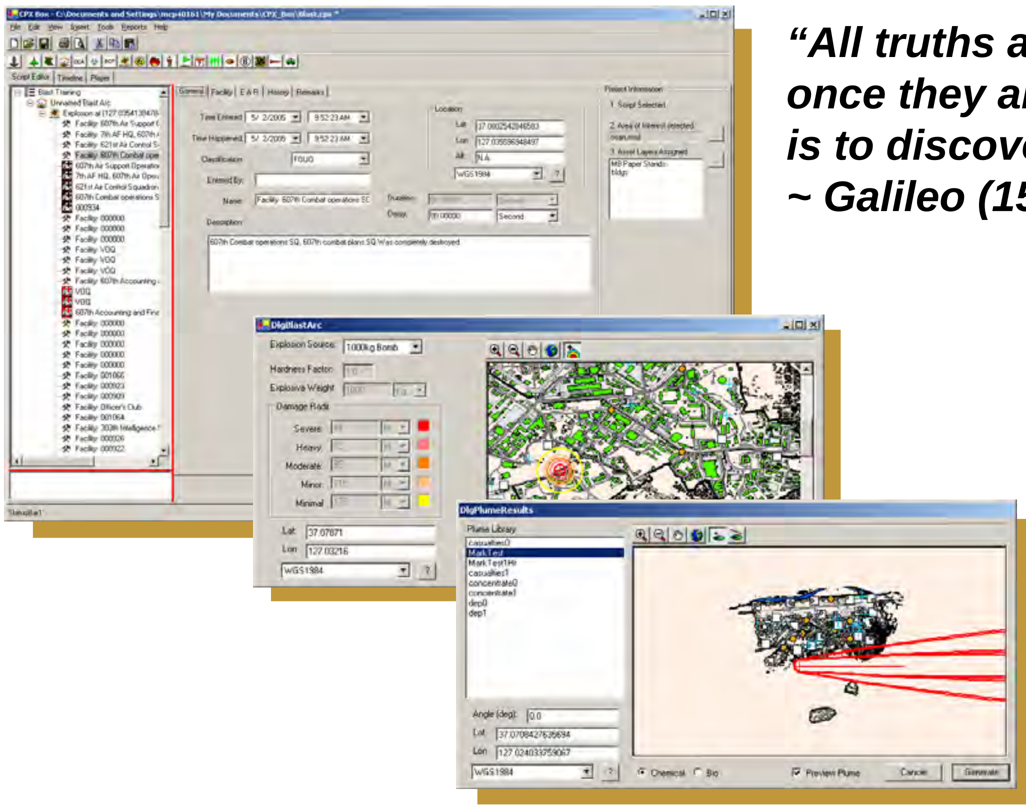

"All truths are easy to understand once they are discovered; the point is to discover them."
~ Galileo (1564-1642)

The Command Post Exercise Box provides operators and analysts the ability to translate modeling and simulation inputs into consequences and consequences into operational understanding.

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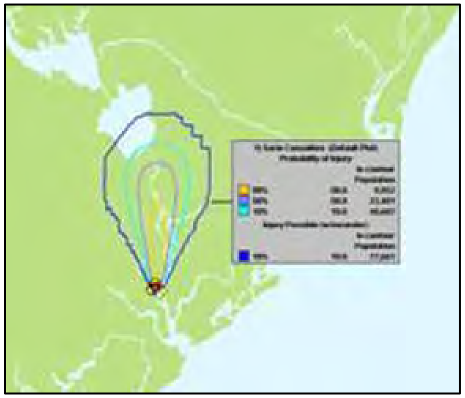
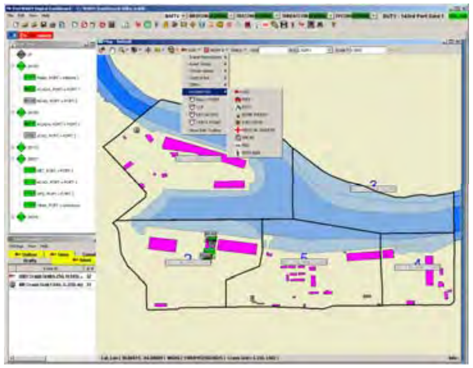
Understanding



CPX

BOX

COMMAND POST EXERCISE TOOL



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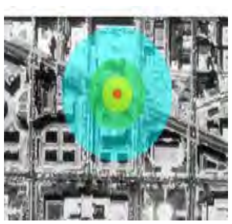
CPX Box

Capabilities

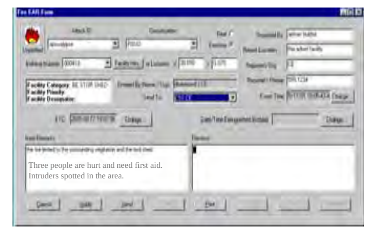
M&S Codes and Heuristics

Application Injects



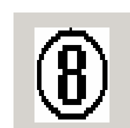
Blast code to determine structural damage and causalities.

CPX Box



Hazard Prediction to determine potential contamination.

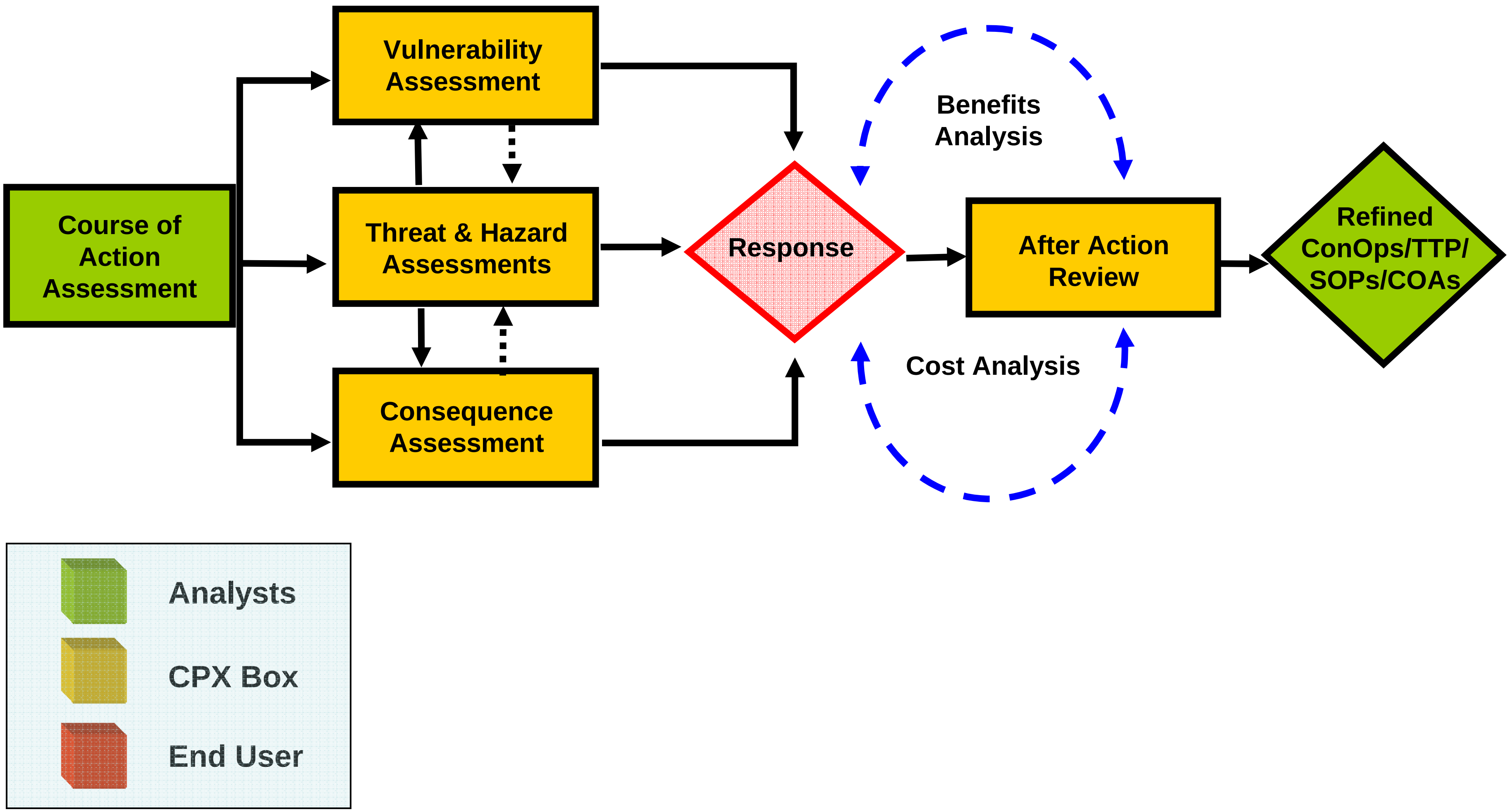
CPX Box



Sensor readings for point and standoff detectors.

CPX Box

CPX Box Concept of Employment



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Questions

S&T for Chem Bio Information Systems Working Group C-I

Dispersion Modeling & Sensor Data Fusion

8:35-9:00	**An Atmospheric Chemistry Module for Modeling Toxic Industrial Chemicals**
9:00-9:30	**Chemical and Biological Hazard Environmental Prediction**
9:30-10:00	**Contaminant Transport and Dispersion Modeling in Urban Areas Using Coupled Meso-Scale (WRF) and Urban Scale (CFD Urban) Models**
10:00-10:30	**Break**
10:30 -11:00	**Coupled Air-Sea Modeling for Improved Coastal Urban Dispersion Prediction**
11:00-11:30	**Measurement of Coastal & Littoral Toxic Material Tracer Dispersion**
11:30-12:00	**Nowcasting and Urban Interactive Modeling Using Robotic and Remotely Sensed Data**
12:00-1:30	**Lunch (On your own)**

S&T for Chem Bio Information Systems
Session C-II
Operations Effects Modeling

8:35-9:00	**JOEF Prototype Development Activities**
9:00-9:30	**Next Generation model Development**
9:30-10:00	**Impact Assessment Tool**
10:00-10:30	**Break**
10:30-11:00	**CHEMRAT and AFMAN 10-2602 Persistence Modeling**
11:00-11:30	**CB System Military Worth Assessment Toolkit**
11:30-12:00	**Predictive Models for Chem-Bio Human Response, Casualty Estimation and Patient Loads**
12:00-1:30	**Lunch (On your own)**

S&T for Chem Bio Information Systems
Session C-III

Battlespace Management

8:35-9:00	Realizing the Promise of NBC Battlespace Management
9:00-9:30	Engineering NBC-RPM
9:30-10:00	Net-Ready CBRN Sensors -- The Way Ahead
10:00-10:30	Break
10:30-11:00	Wirelessly Enabling Legacy Sensor Systems for Rapid Deployment and Monitoring
11:00-11:30	Dynamic Multi Sensor Management System
11:30-12:00	TBD
12:00-1:00	LUNCH (On your own)

S&T for Chem Bio Information Systems
Session C-IV
Decision Making and Support

8:35-9:00	**Monotone Measure Theory as a Method for Combining Evidence in Threat Managements**
9:00-9:30	**Algorithmically Generated Music Enhances VR Decision Support Tool**
9:30-10:00	**Exploring Optimization Methodologies for Systematic Identification of Optimal Defense Measures For Mitigating *CB* Attacks**
10:00-10:30	**Break**
10:30-12:00	**Multivariate Decision Support Tool Set-up**
12:00-1:30	**Lunch (On your own)**

S&T for Chem Bio Information Systems Session C-V

Special Topics: Test and Evaluation

8:35-9:00	**Active Standoff Chemical Detection Model for System Studies**
9:00-9:30	**CBRN Data Model Implementation Approach**
9:30-10:00	**Chemical Homeland Security System (C-HoSS)**
10:00-10:30	**Break & *Joint Project Manager Information Systems Demo (Last Chance to view Demo)***
10:30-11:00	**Program Decision Issues**
11:00-11:30	**Program Decision Issues**
11:30 -12:00	**Program Decision Issues**
12:00-1:30	**Lunch (On your own)**

S&T for Chem Bio Information Systems
Working Group D-I
Dispersion Modeling & Sensor Data Fusion

1:30-2:00	**Release and Atmospheric Dispersal of Liquid Agents**
2:00-2:30	**Modeling and Simulation to Support Virtual Chemical Hazard Environments**
2:30-3:00	**Translation of JEM Accuracy Requirement into a Measurable Acceptability Criterion**
3:30PM	***Conference Adjourns***

S&T for Chem Bio Information Systems
Session D-II
Operations Effects Modeling

1:30-2:00	Combined Defense Model
2:00-2:30	Health Effects Decision Support Tool for Civilian CB Air and Water Attack Scenarios
2:30-3:00	Employing Military Virtual Reality Simulation Technology to Train for Prevention, Deterrence, Response, and Recovery for Chem Bio Events
3:30	*Conference Adjourns*

JPEO-CBD

CBRN Data Model Implementation Approach

October 28, 2005

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JPEO CBD SSA Data Management Lead
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Naval Postgraduate School
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Briefing Agenda

- Introduction
- CBRN Data Model Background
- Why this paper?
- A Phased Approach
- Create Data Model and XML Schema
- Data Structures and Data Sets
- RDBMS XML Interface
- Security and Information Assurance (IA)
- Develop Discovery and Web Services
- Integration with Other COIs
- Future Direction
- Questions

CBRN Data Model Background

- For improved interoperability the JPEO CBD needed a common data representation for the 3 Programs of Record
  - JWARN, JEM and JOEF
- Based on Command and Control Information Exchange Data Model (C2IEDM) and being extended to meet the CBRN COI data needs
- Migrating the baseline to J3IEDM
- Common data model in the community provides common semantics and syntax as per DoD Net-Centric Data Strategy
- Adopted by NATO ATP45 Panel
- Adopted by the JPEO CBD and JRO as 'THE' DODAF OV-7

Why this paper?

- How do I implement the Data Model?
- Educate the community to the concept of Net-Centric Enterprise Services (NCES) and DoD's Net-Centric Data Strategy
- Show a progressive path starting from the data model to a Service Oriented Architecture (SOA)

A Phased Approach

1) Create the Data Model and the XML Schema
2) Create a Physical Data Structure and Accredited Datasets
3) Create a Relational Database Management System (RDBMS) XML Interface
4) Security and Information Assurance
5) Develop CBRN Discovery and Web-Services
6) Integration with Other Discovery and Data Services

Create Data Model and XML Schema

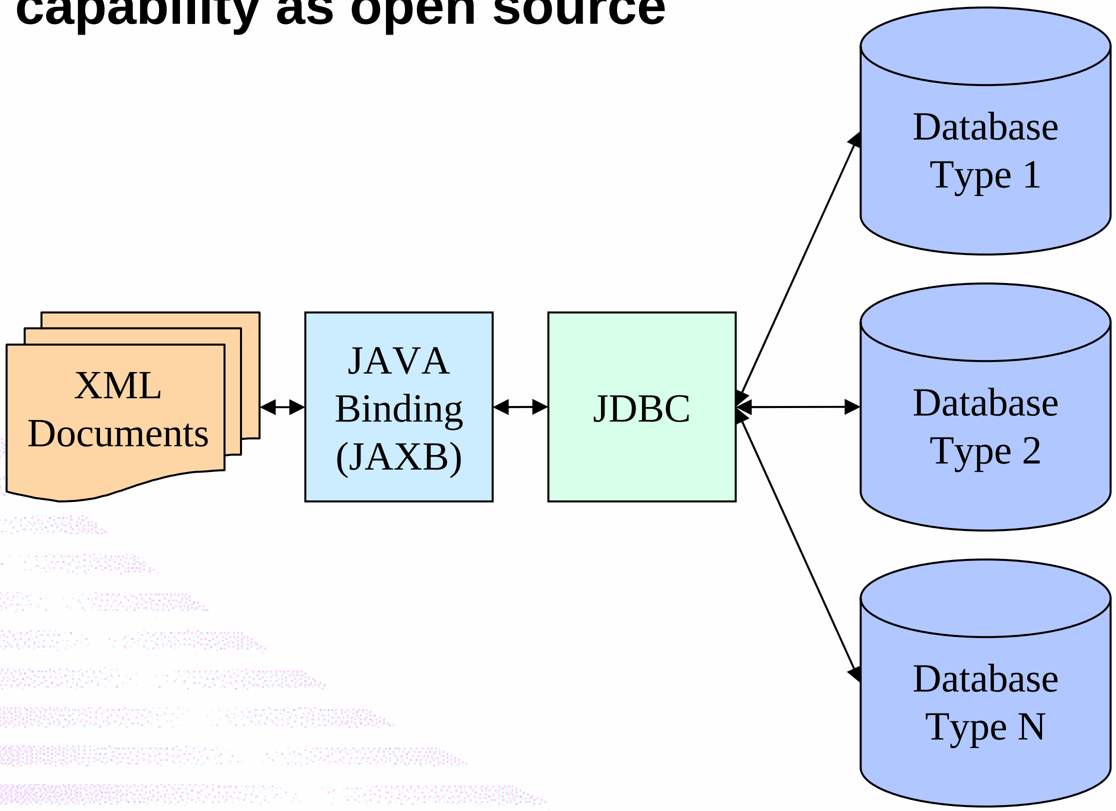
- Create the CBRN Data Model
- Generate the CBRN XML Schema
- Develop a Configuration Management Process
  - Internally uses UDPs for tracking modifications and requirements
  - Externally uses JPM IS Data Team's CM process but will transition to the JCBRN CMP process
- Verify, Validate and Accredit the Data Model
  - Data APM holds periodic technical reviews
  - V&V through the armed services by way of a JRO JSAP task
  - NATO V&V through the U.K. Defense Science and Technology Laboratory (DSTL)
- Life-cycle Maintenance
  - The data model is still being rapidly expanded in numerous subject areas.

Data Structure and Datasets

- Create a Physical Data Structure
  - Object Oriented Database (OODB)
  - Relational Database Management System (RDBMS)
  - ERwin modeling tool generates database creation scripts
- Test (Range and Boundary) Dataset
  - All ranges, data types and enumerations
- Use-Case (Scenario) Dataset
  - Application and scenario specific
- Legacy Data Structures
  - Will need to convert or create an XSLT design document that maps the legacy structure to the CBRN XML Schema
  - XSLT design document will be provided to JPM IS Data Team and JCBRN Architectural Working Group (JCBRN AWG)

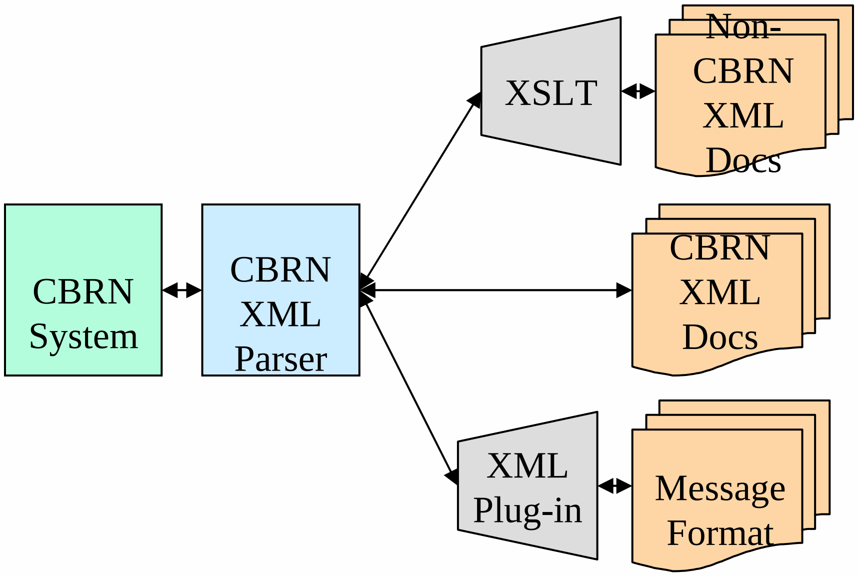
RDBMS XML Interface

- Create an XML Interface
  - DoD mandates XML for data exchange
  - Recommend development of a JAVA Binding (JAXB) in conjunction with JAVA Database Connectivity (JDBC)
  - Provide capability as open source



RDBMS XML Interface

- Legacy Systems
  - Need to develop a web service interface to include an XSLT
  - Non-XML messaging formats will require XML plug-ins
- Establish a JPM IS Test Bed to test XML interfaces and all CBRN web services
  - Formal testing provided by the Joint Interoperability Test Command (JITC)



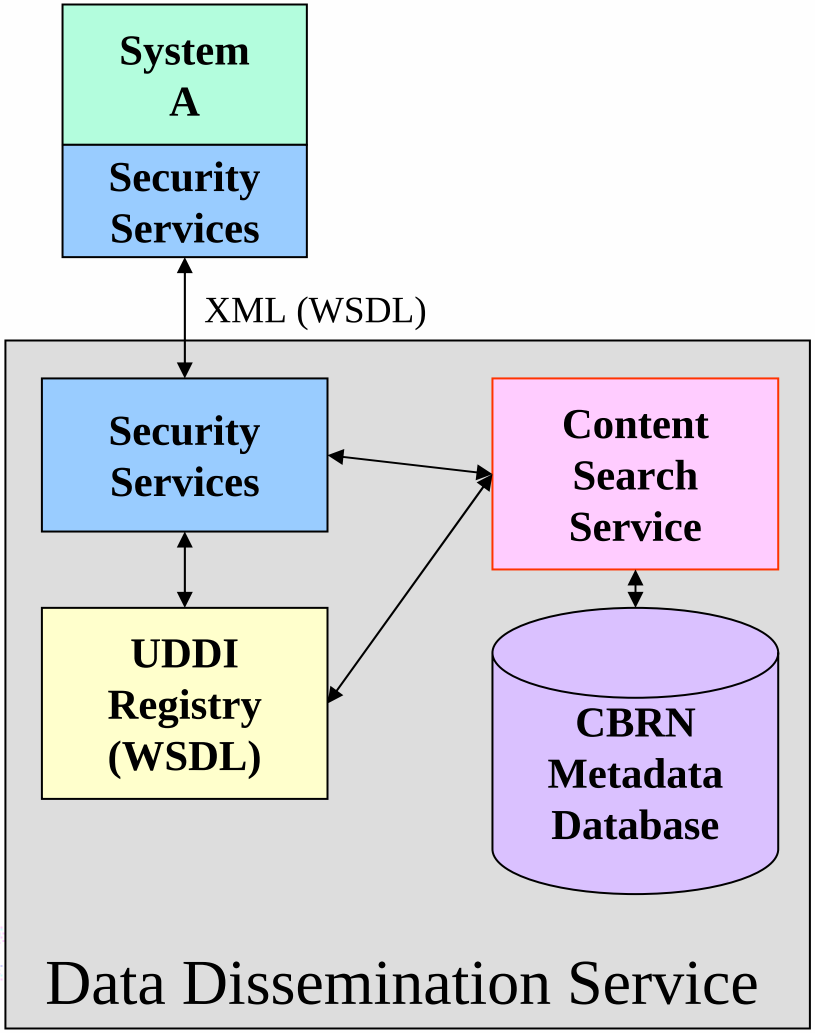
Security and Information Assurance (IA)

- NCES IA Services
  - Utilize and integrate with available NCES Security Services
- Role-Based Access
  - CBRN Discovery Metadata can support the development of role based access
  - Monitor NCES Security Services capabilities as it migrates from role-based to attribute-based access

Develop Discovery and Web Services

- Develop Data Services for Authoritative and Content Data
- Publish a Web Service
  - Develop and publish service using Web Service Description Language (WSDL)
  - Register web services on a Universal Description Discovery and Integration (UDDI) Registry
- Develop a Discovery Service
  - Needed for web services and data content
  - CBRN metadata used in search engine to discover local data content
  - Leverage existing NCES Discovery Services

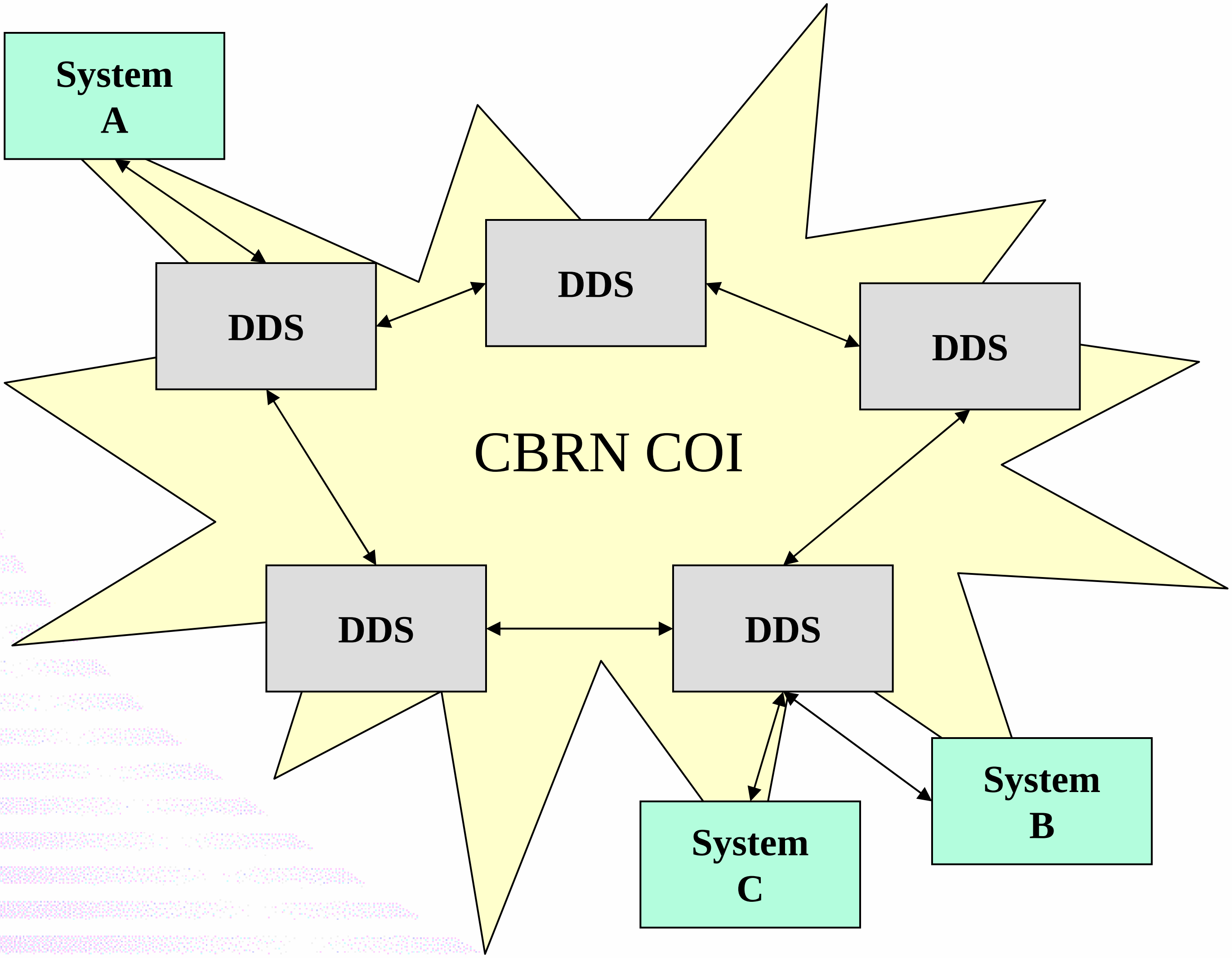
Data Dissemination Services (DDS)



Leverage Net-Centric Enterprise Services to develop a DDS

JPEO-CBD

DDS Enterprise



DDS will broadcast web services and discovery metadata

Integration with Other COIs

- How do I interact with other COIs?
- Mapping and Discovery Services
  - Mapping between COIs will utilize XSLTs for both discovery metadata and data content
- Three Methods of Sharing Data Elements
  - Translated Approach
    - No coordination
    - Usage of XSLTs and NCES Mediation Service
  - Formal Coordinated Approach
    - COIs agree to share the data element with one acting as the Steward
    - Stakeholder submits modification thru CM process and is voting member of the CCB
  - Informal Coordinated Approach
    - Steward maintains the data element
    - Stakeholder monitors the element for changes

Future Direction

- There is a need for follow on papers
  - CBRN COI Implementation Strategy
    - A technical plan that describes the components used to create the CBRN COI and how they will interact. This will also include operational recommendations on how to utilize the CBRN COI components.
  - CBRN COI Implementation Plan
    - Would address the programmatic, scheduling and responsibilities for implementing the pieces of the CBRN COI and when those pieces will be fielded. This paper should also include an overall deployment plan.
  - CBRN Data Model Implementation Use-Case(s)
    - These papers should provide a specific example of how the data model was actually implemented. Additional use-case papers should be written describing other aspects of the CBRN COI as the COI matures.

Questions

- Questions?

JOEF Prototype Development Activities

Dr. Tom Stark
Cubic Defense Applications
26 October 2005

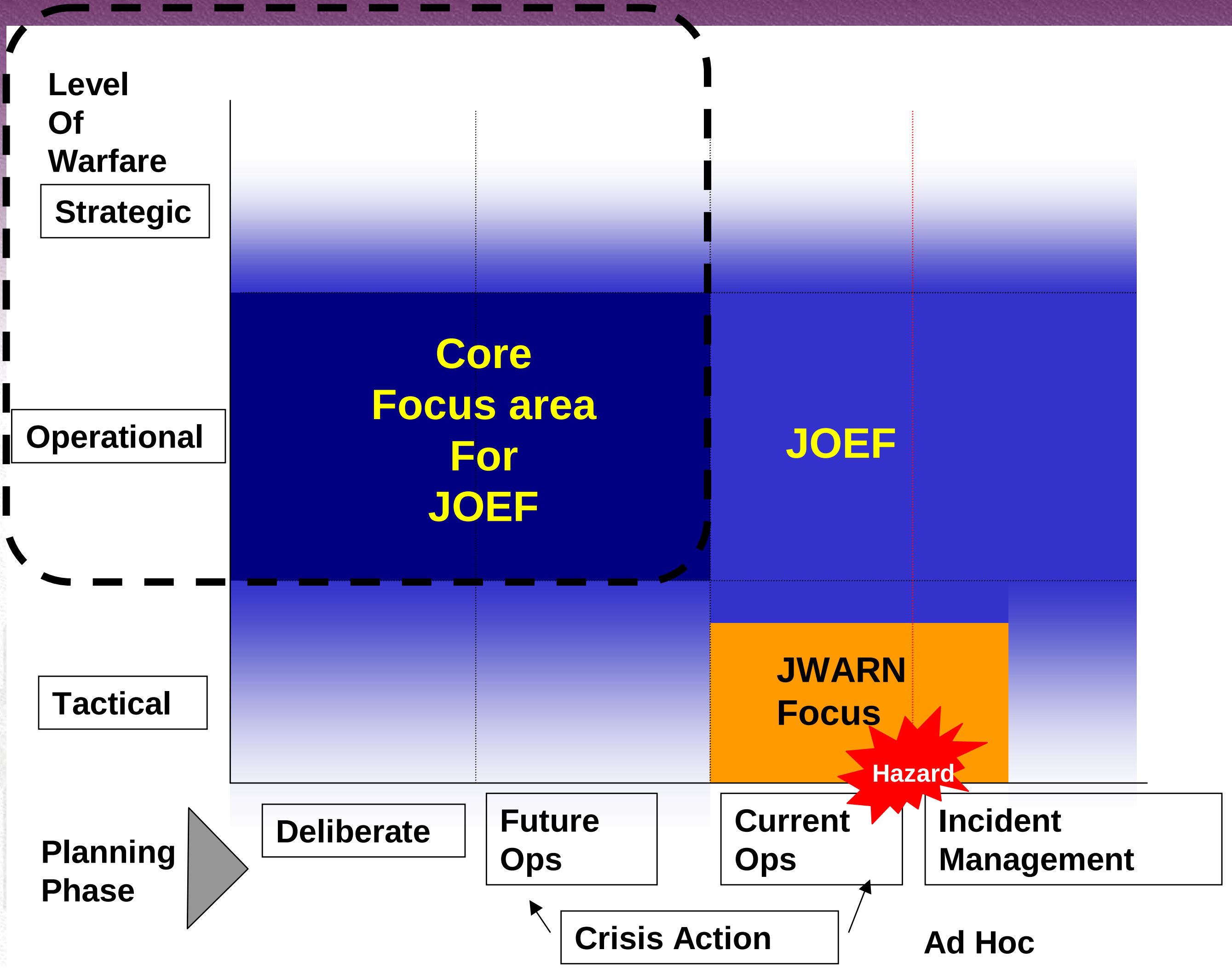
Presentation Outline

- JOEF Prototype Development Team
- JOEF Focus Areas and Concept
- JOEF Prototype Development Process
- COCOM/User Visits
- Summary

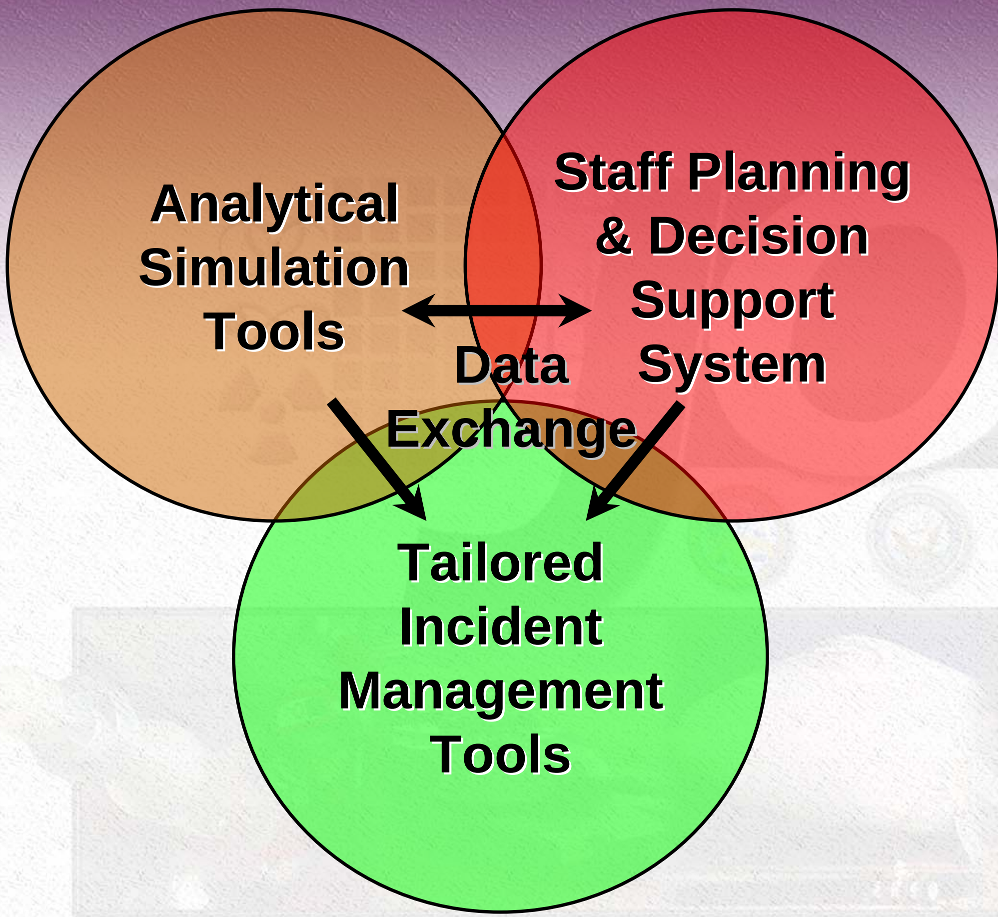
JOEF Prototype Development Team

- DoD/Government
  - Joint Science & Technology Office (JSTO)
  - SPAWAR (JPM-IS)
  - Air Force Research Labs (AFRL)
  - US Army Office of the Surgeon General (OTSG)
- Contractors
  - Cubic
  - Anteon, Inc.
  - ScenPro, Inc.
  - General Dynamics (Prototype I)

JOEF Focus Area

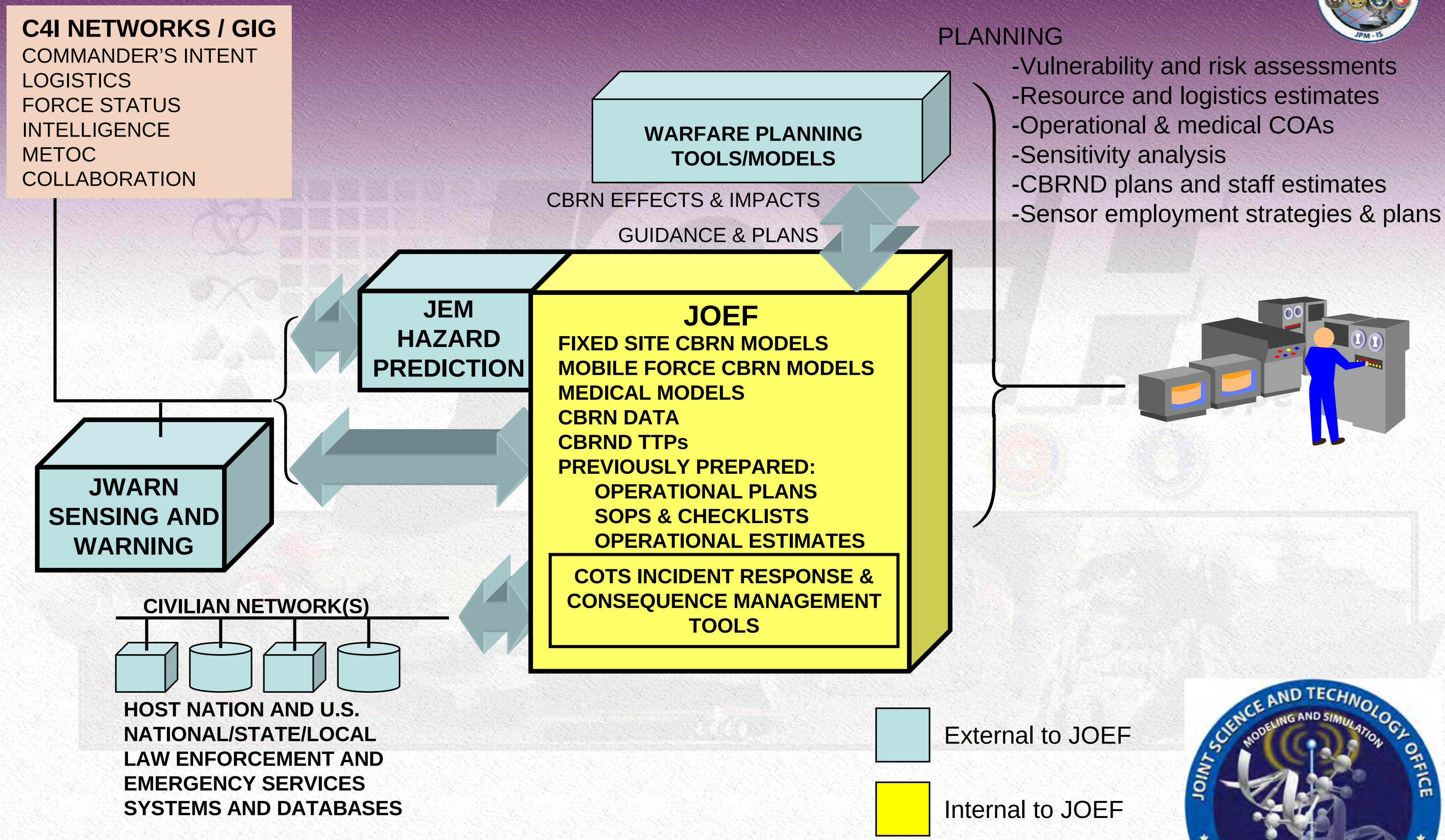


Basic JOEF Concept



- Staff Planning & Decision Support tools automate/facilitate planning processes
- Modeling tools used within planning processes
- Incident Management tools added with JOEF Increment 2

JOEF Components and Interfaces



JOEF Technology Selection Process

JOEF

- MODELING
  - FIXED SITE OPERATIONS
  - MEDICAL OPERATIONS
  - MOBILE FORCE OPERATIONS
  - CBRN EFFECTS CALCULATORS
  - SENSOR PLACEMENT
- TASK MANAGEMENT
  - STAFF PRODUCTS
  - TTP/SOP EXECUTION
- LOCAL DATA

3 FTAs

FTA I:
Fixed Sites & Medical
RFI issued: 6 Jan 2003
Completed: June 2003
26 responses

FTA II:
Mobile force, Decision Support
RFI issued: 9 Dec 2003
Completed: 1 Apr 2005
47 responses

FTA III:
Business Process Management
RFI issued: 3 Mar 2005
Completed: July 2005
27 responses

Functional Components evolved in response to user feedback from prototype demonstrations

Underlying JOEF Technology

Analytical Simulation Tools

STAFFS
NBC CREST

CHEMRAT
NBC Planner
Electronic VAT

Not included

Bonita
Google Search

Staff Planning & Decision Support System

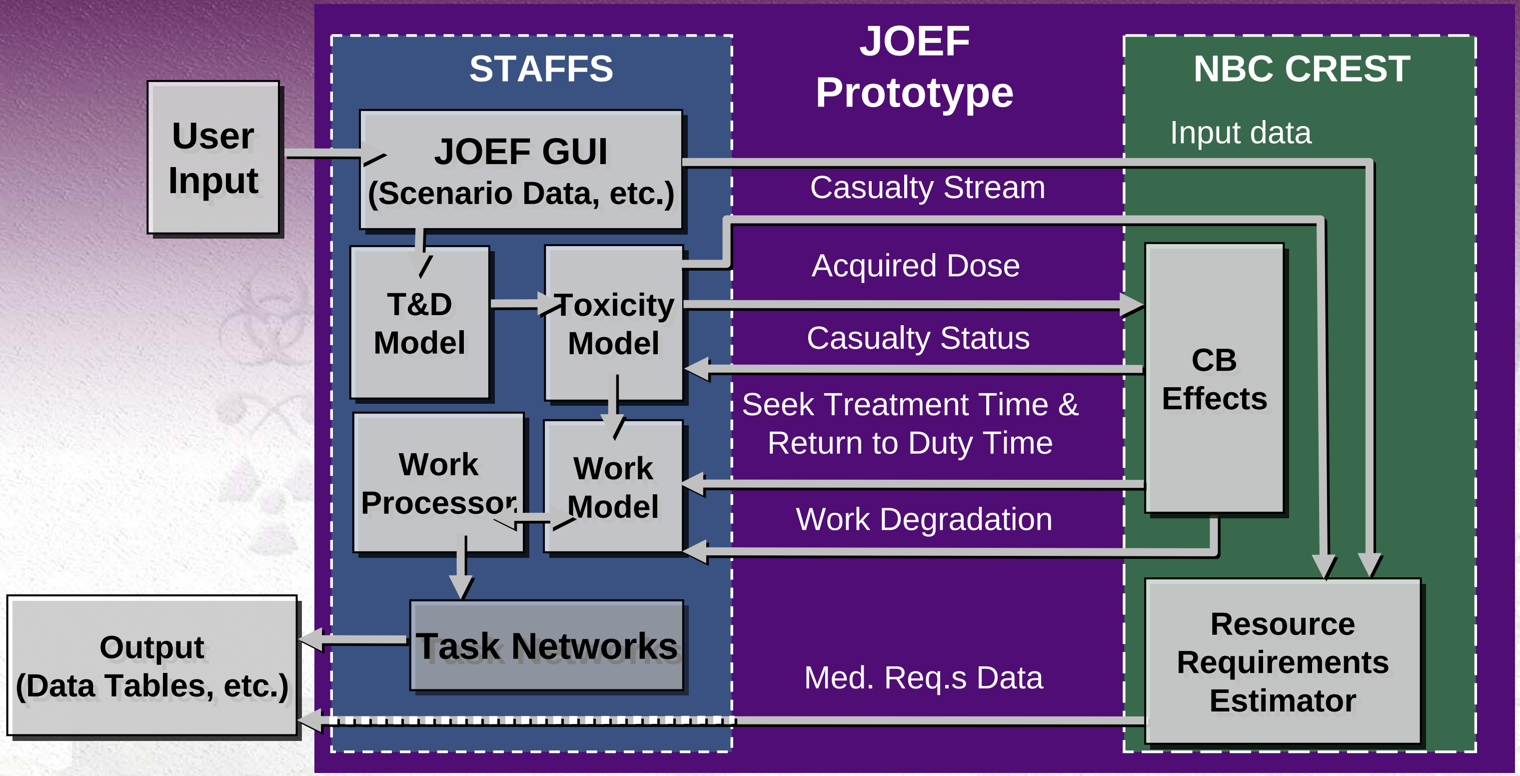
JOEF

- MODELING
  - FIXED SITE OPERATIONS
  - MOBILE FORCE OPERATIONS
  - MEDICAL OPERATIONS
  - CBRN EFFECTS CALCULATORS
  - SENSOR PLACEMENT
- TASK MANAGEMENT
  - STAFF PRODUCTS
  - TTP/SOP EXECUTION
- LOCAL DATA

Component selection based on:

- Focused Technology Assessments
- User Feedback gained from COCOM and other visits

JOEF Prototype I Integration



- STAFFS model estimates operational effects to military operations
- NBC CREST estimates effects of agents on population, and medical resources

JOEF Prototype II and III Efforts

- Prototype II Integration Efforts:
  - Modify Resource Requirements estimation capability to allow stochastic modeling
  - Integrate NBC Calculator and CHEMRAT into JOEF Prototype
  - Apply graphical post-processing capability
- Prototype III Integration Efforts:
  - Adapt architecture to begin migration to multi-tier architecture
  - Modify GUI to leverage C/JMTK tool, and to simplify data input/output capabilities
  - Develop SPOD operations model
  - Develop Mobile Forces operations model
  - Investigate automated task management capabilities

COCOM/User Visits

- Objectives:
  - Understand the processes and tools that COCOMs and other uses employ in planning process
  - Help understand Mobile Force modeling requirements
  - Develop rapport with potential tool users
- COCOMs Visited:
  - CENTCOM
  - TRANSCOM
  - NORTHCOM
  - JFCOM
  - I-Corps
  - USARPAC
  - PACFLT

Summary

- JOEF Prototype efforts demonstrated how off-the-shelf technologies could be leveraged to support JOEF program goals
  - CB Science & Technology products
  - COTS, Open systems products
- JOEF Prototype demonstrations were used to showcase capabilities, and to shed light on JOEF tool requirements
- The JOEF Prototype is *NOT* the JOEF tool; further development and integration is required to produce the JOEF tool

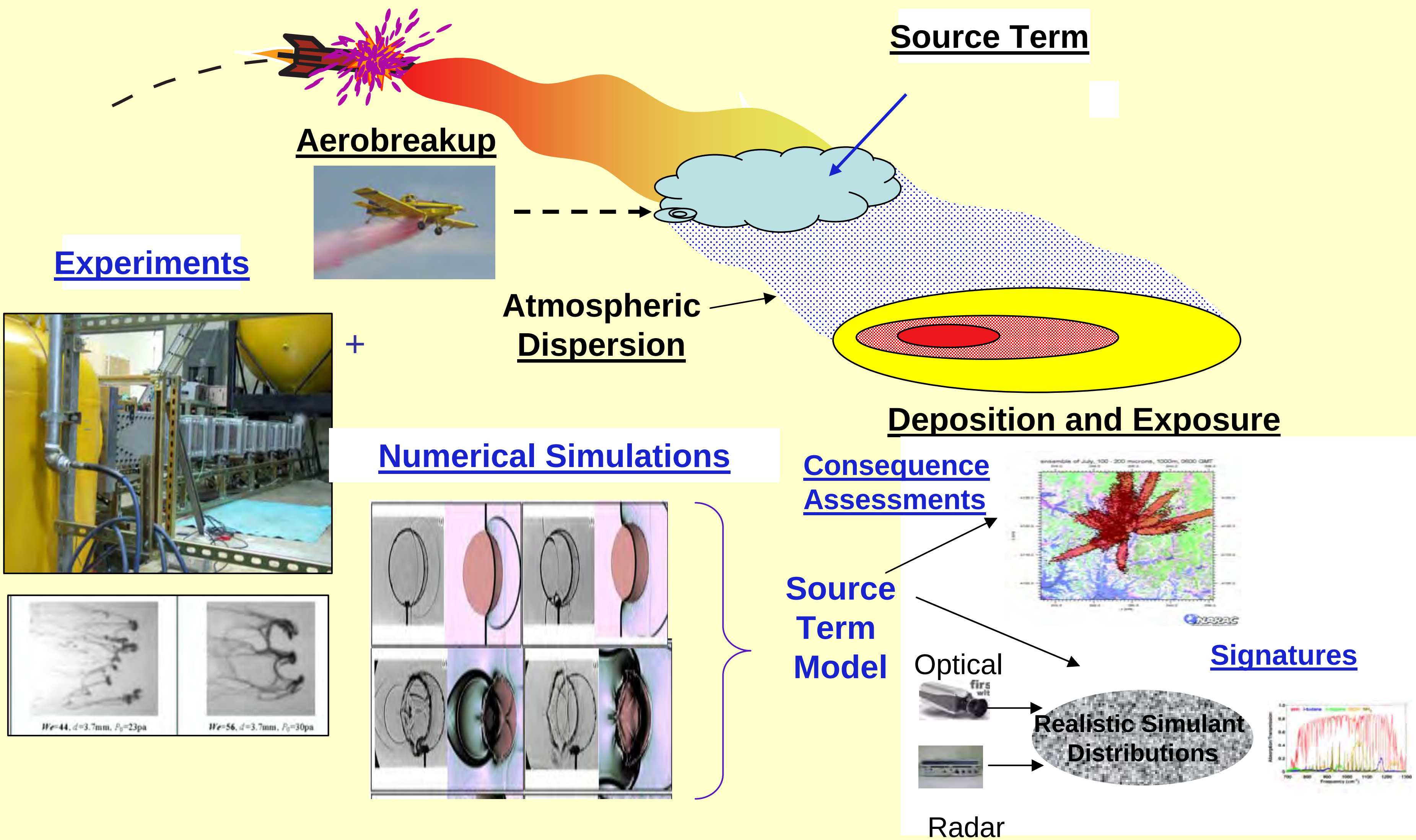
RELEASE and ATMOSPHERIC DISPERSAL of LIQUID AGENTS

Theo Theofanous (PI)
University of California, Santa Barbara

Rich Couch, Program Manager
Lawrence Livermore National Laboratory

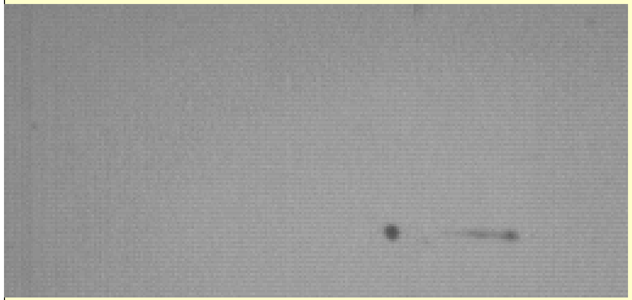
S&T CBIS October 25-28, 2005

Operational Capability to be Provided



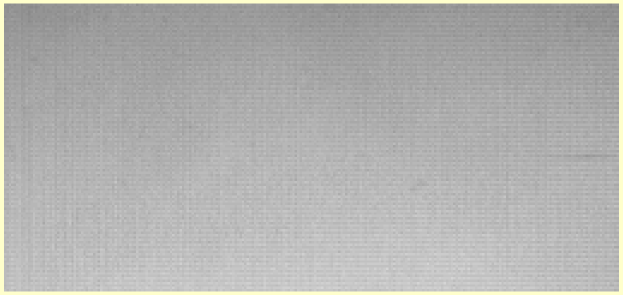
Controlling Mechanisms: VISCOELASTICITY

Rather than breaking into droplets, viscoelastic liquids tear into threads and sheets that resist pinch-off



Newtonian

Viscous



Viscoelastic

"Thickener" is added precisely for the purpose of controlling atomization . . .

Concentration and Length of Polymer Chain selected to "Tailor" Effect

Controlling Mechanisms: Aerodynamic History

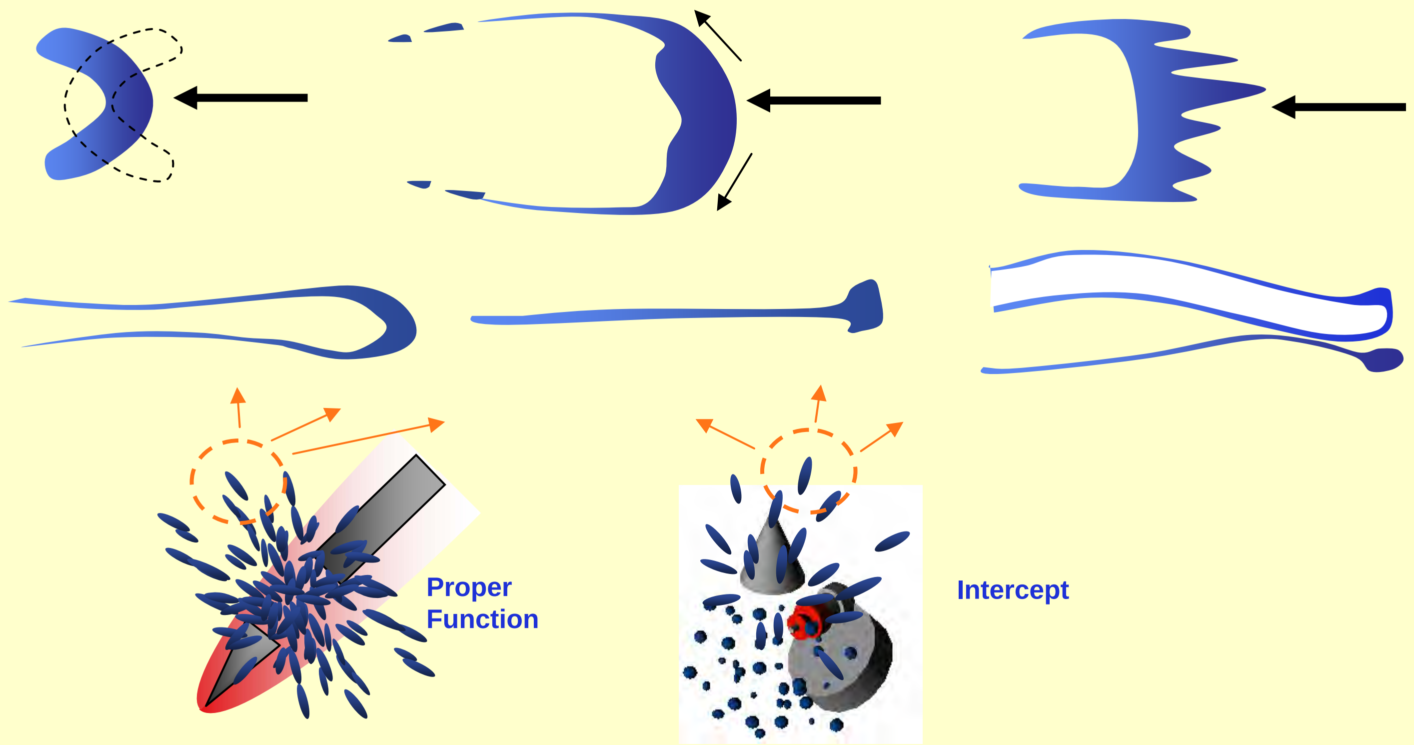
Aerodynamic interactions result in a complex superposition of mechanisms that are highly sensitive to ρv^2.

Deformation | **Shear Flow** | **Interfacial Instabilities**

Newtonian

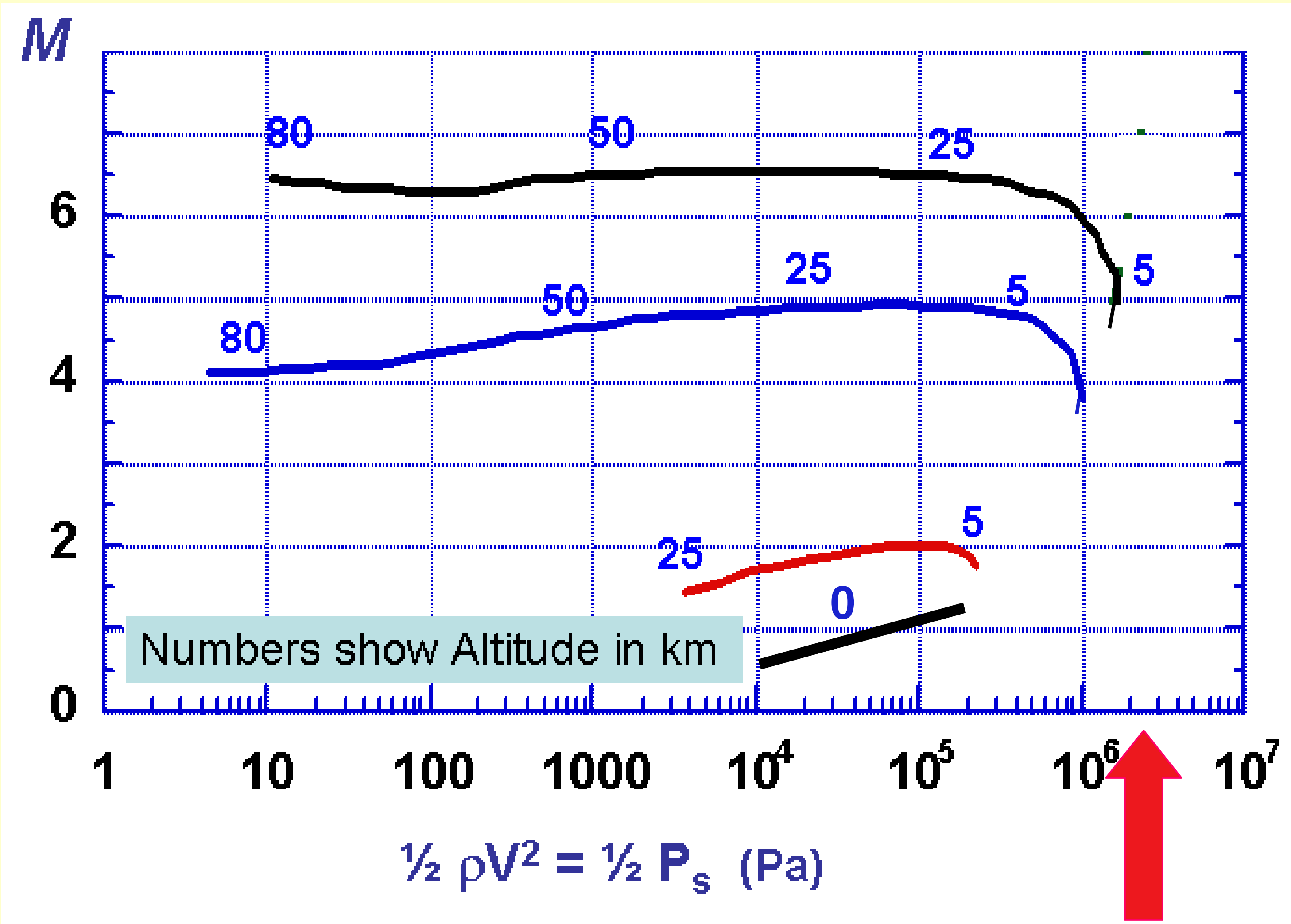
Viscoelastic (local)

System (global)



Scaling: From Droplet……to Beer Can…… to Warhead Quantities

All Release Conditions are Achievable in Experiments



Using the Laboratory as Frame of Reference Makes Measurements Possible

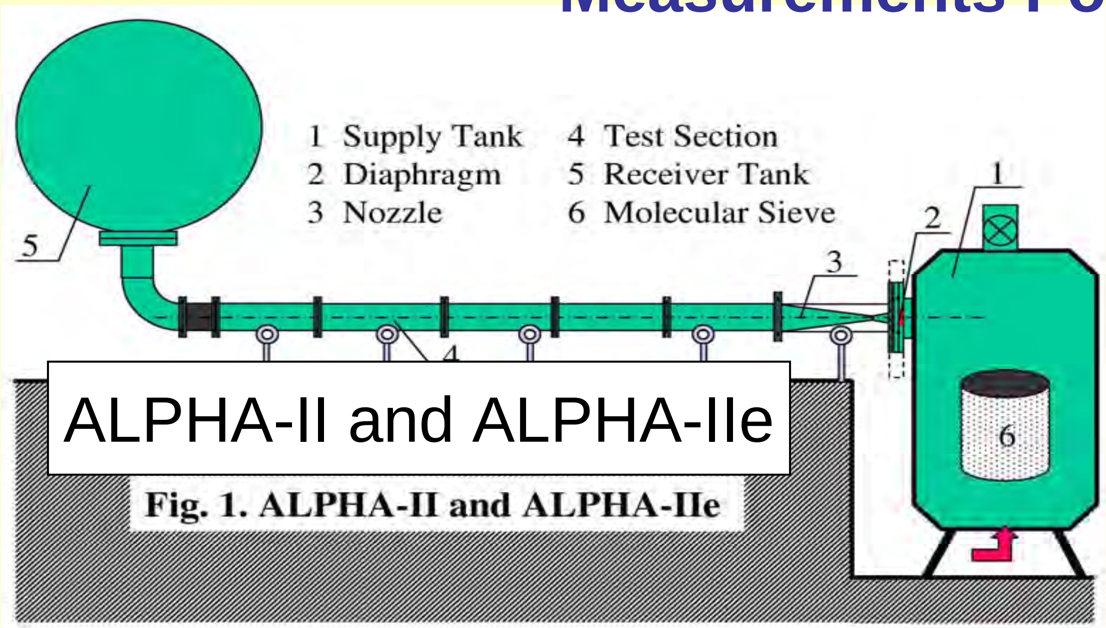
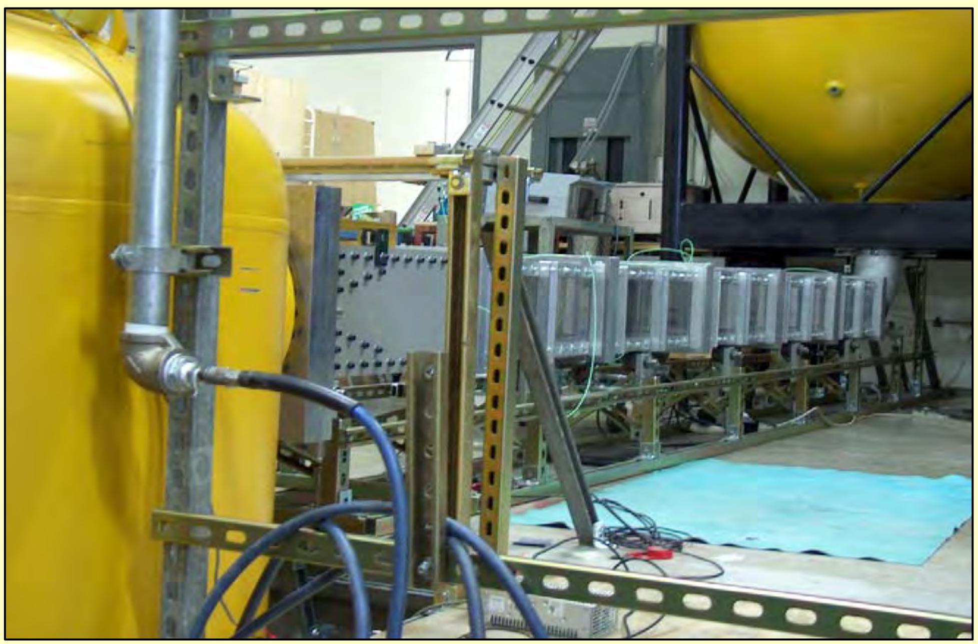


Fig. 1. ALPHA-II and ALPHA-IIe



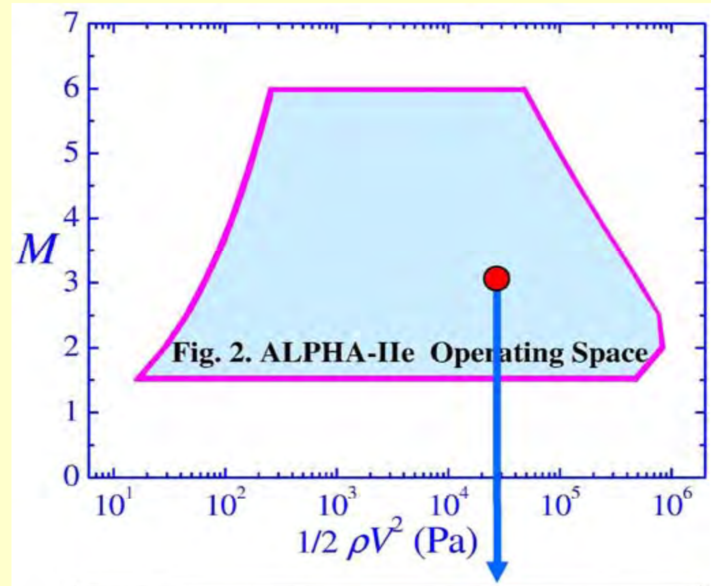


Fig. 2. ALPHA-IIe Operating Space

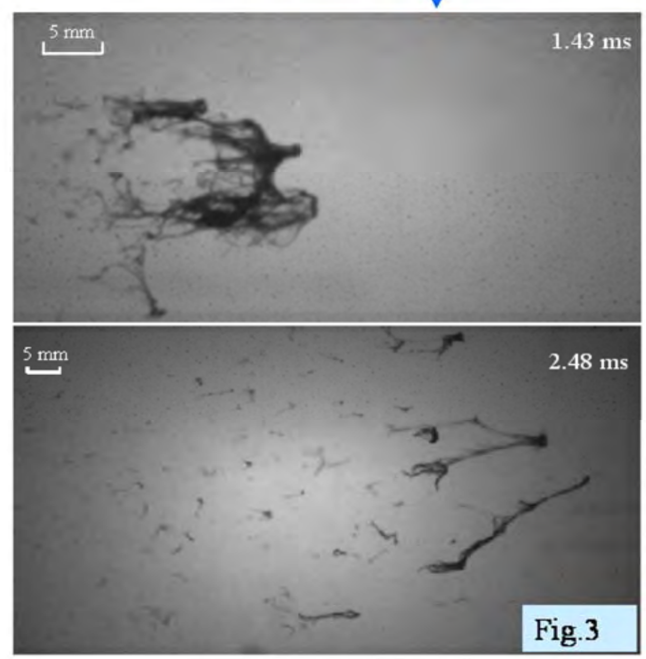
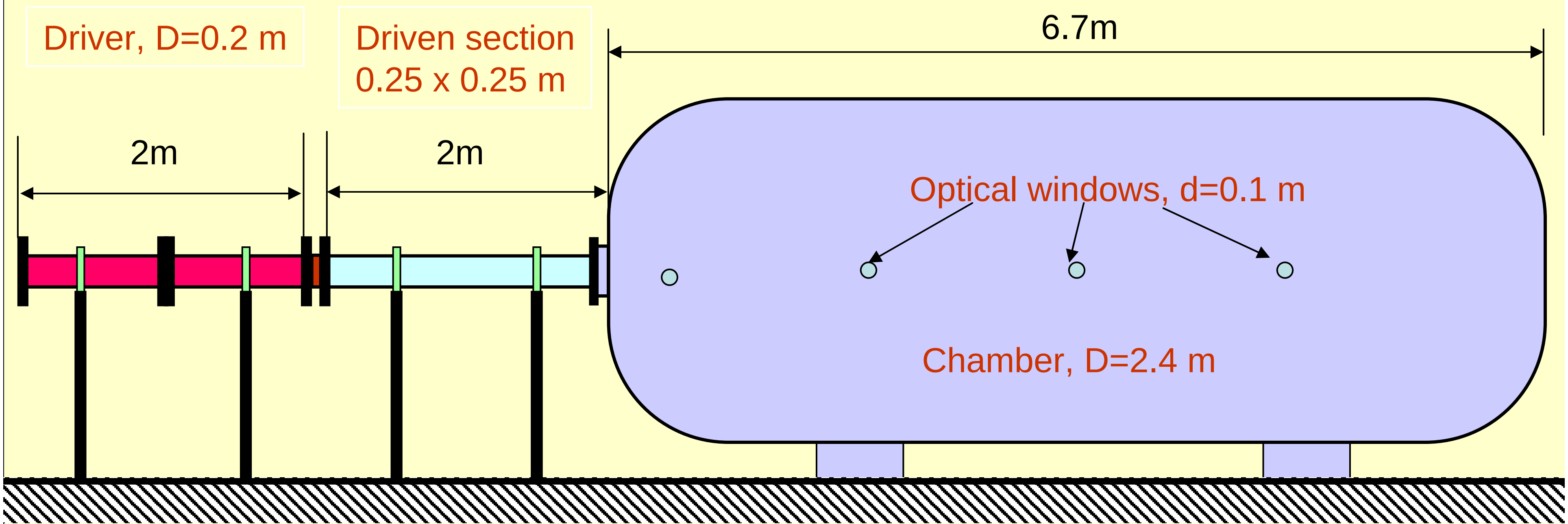
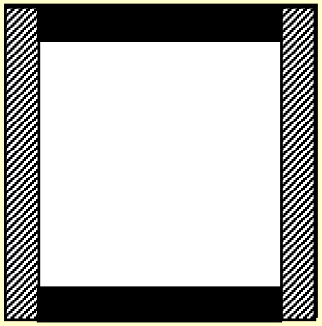


Fig.3

ASOS Overall (1: 45)



Cross section of Expansion section (1:8)



Special : He-N_2 & Discontinuity
Aerodynamic History

A Hierarchy of Objectives

Local Scaling ……. We, M, Oh, R_τ…….. **Lower Bound**

Principally with Experiments/Theory/DNS

System Scaling..........Realistic/Predictive/Adaptable

mass ratio

release (boundary) conditions

aerodynamic history……

shielding

coalescence

shock dynamics

cloud permeability

length scales (We,M,Oh,R_τ)

Principally with Experiments/Theory/EFM

Major Results

- On Data Base development we have proven all aspects of the experimental technique and begun Production Runs (well ahead of schedule),
- We have shown experimentally that VE drops can survive intact at We~ 4,000! Or $1/2\rho v^2 = 2\ 10^5$!
- We developed a theoretical understanding of the mechanisms for Newtonian/Viscous liquid breakup over the whole range of regimes, unified all data, and corrected major, long-standing misconceptions,
- On DNS we achieved the sharp treatment of interfaces, and established capability to compute instabilities on shocked, high acoustic impedance mismatch interfaces.

Scope of this Presentation

- Develop Data Bases (Experiments)

  $10^4 < \frac{1}{2}\,\rho v^2 < 10^5$, M=3 (ALPHA II); ND, VD ;

- Understand Key Physics (Discrete/Dilute)

  Break-up Regimes with Newtonian (Viscous) Liquids

- Understand Key Physics (Discrete/Dilute)

  Break-up Regimes with Viscoelastic Liquids (Small Drops)

- Sharp Treatment of Interfaces

  Fidelity of Instability Prediction by DNS

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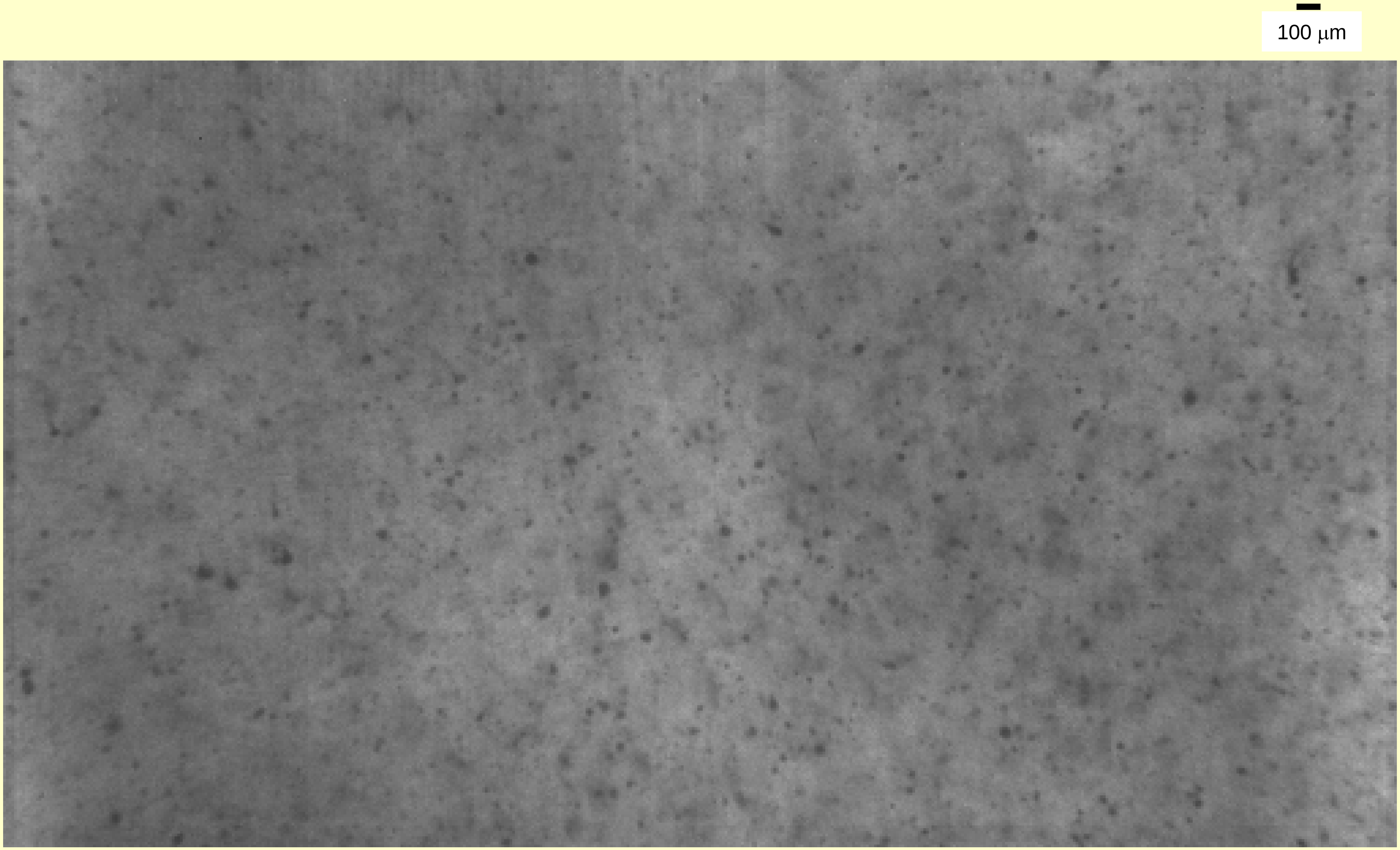
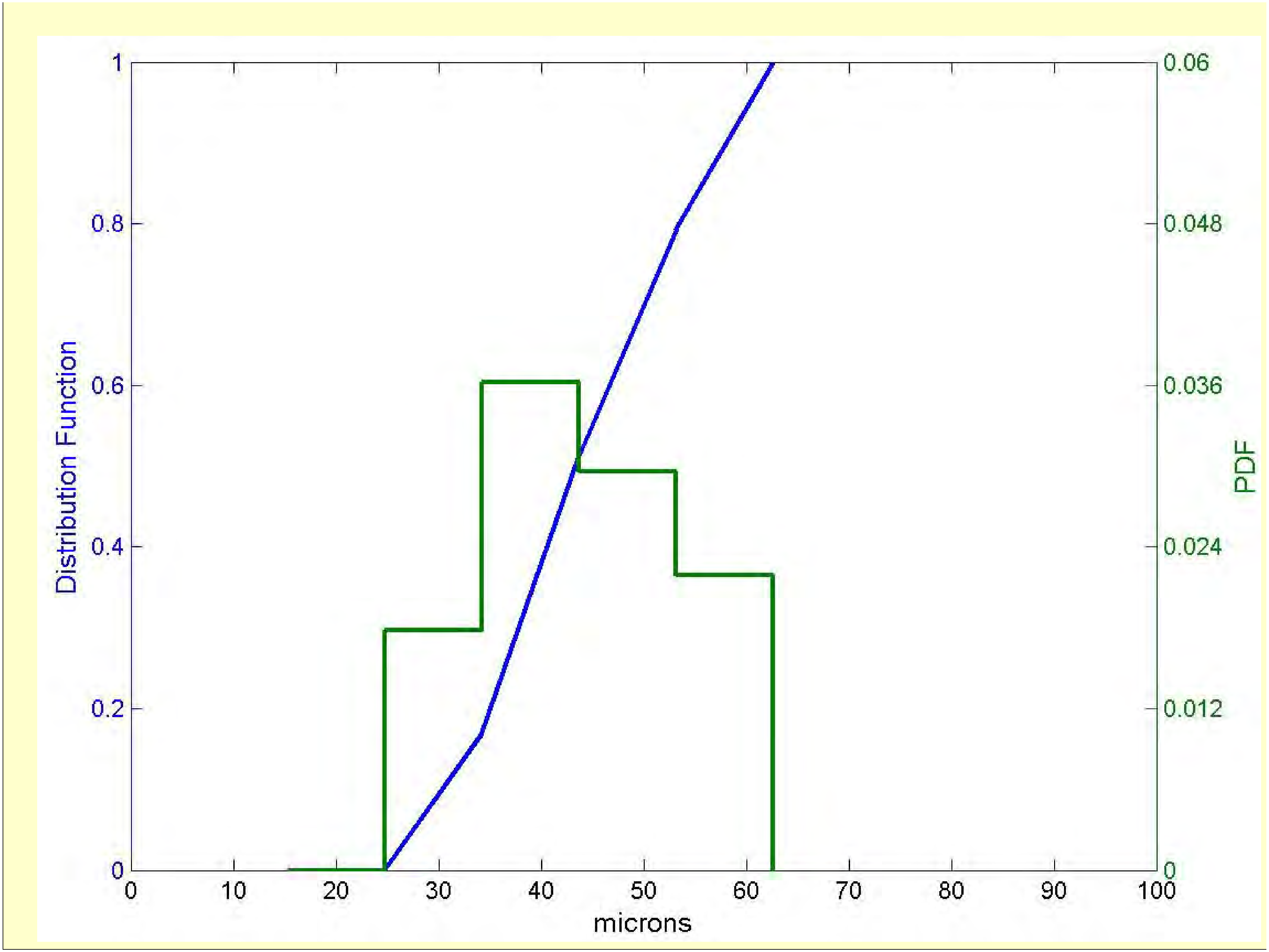
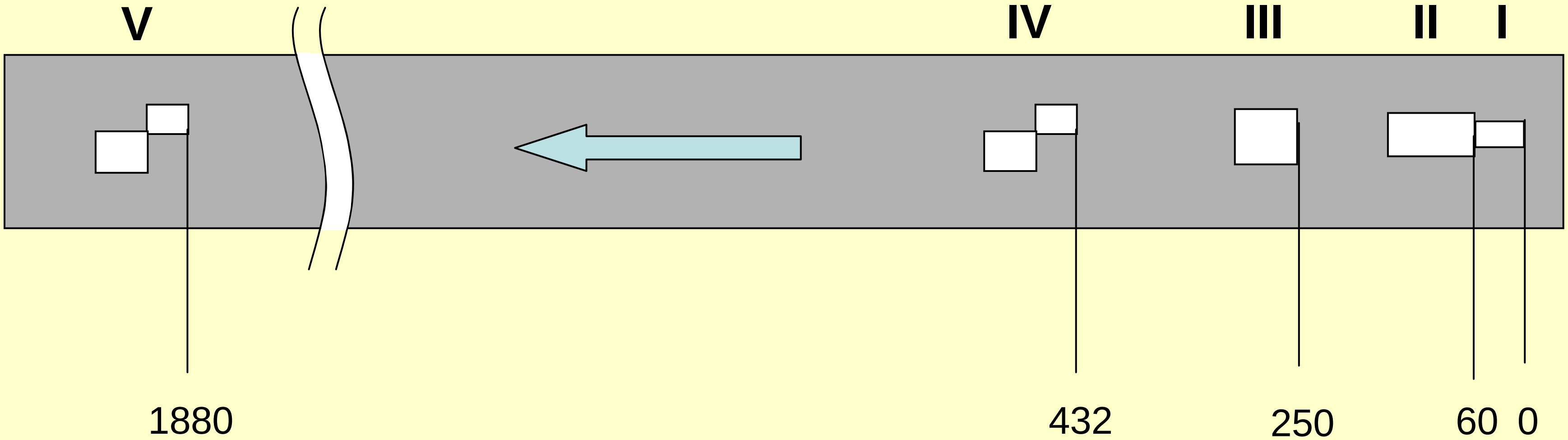
We have the first Newtonian Particle Size Distributions in the shear regime





Distribution Function
PDF
microns
1
0.8
0.6
0.4
0.2
0
0.06
0.048
0.036
0.024
0.012
0
0
10
20
30
40
50
60
70
80
90
100

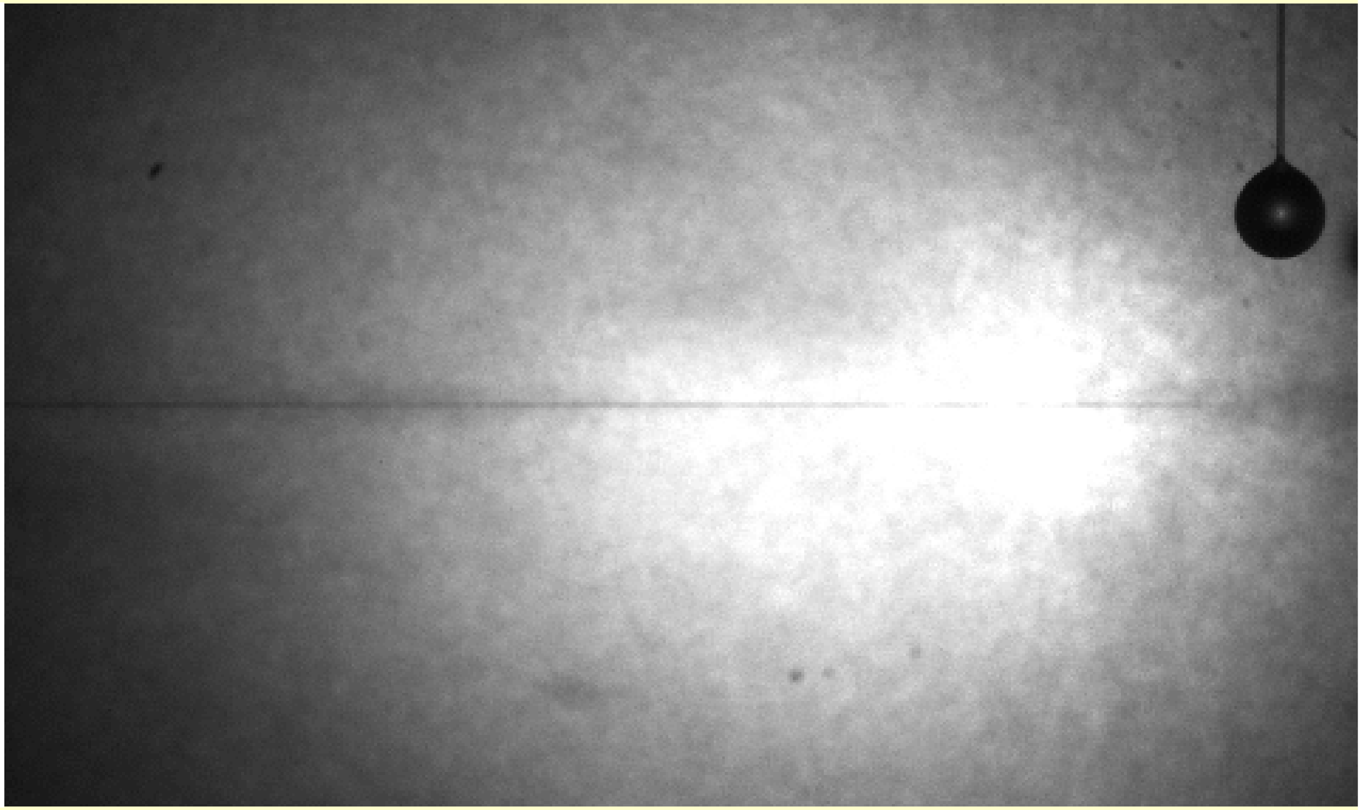
Stage Arrangement



Stages I – V are sampling stages using high-speed cameras.

Unit: mm

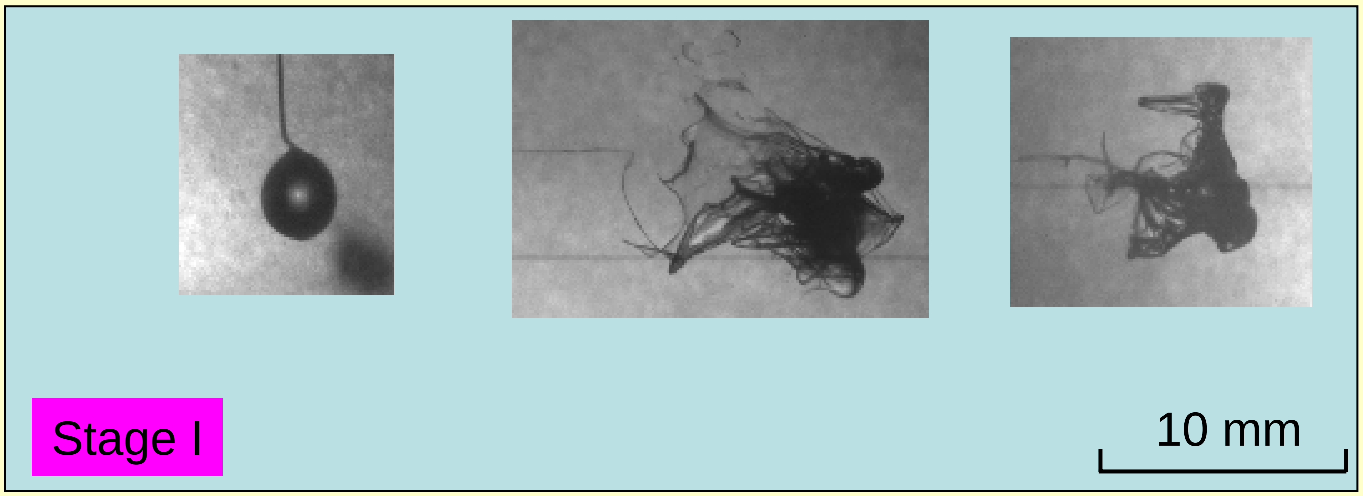
Breakup at ½ ρV^2 of 10^5 Pa



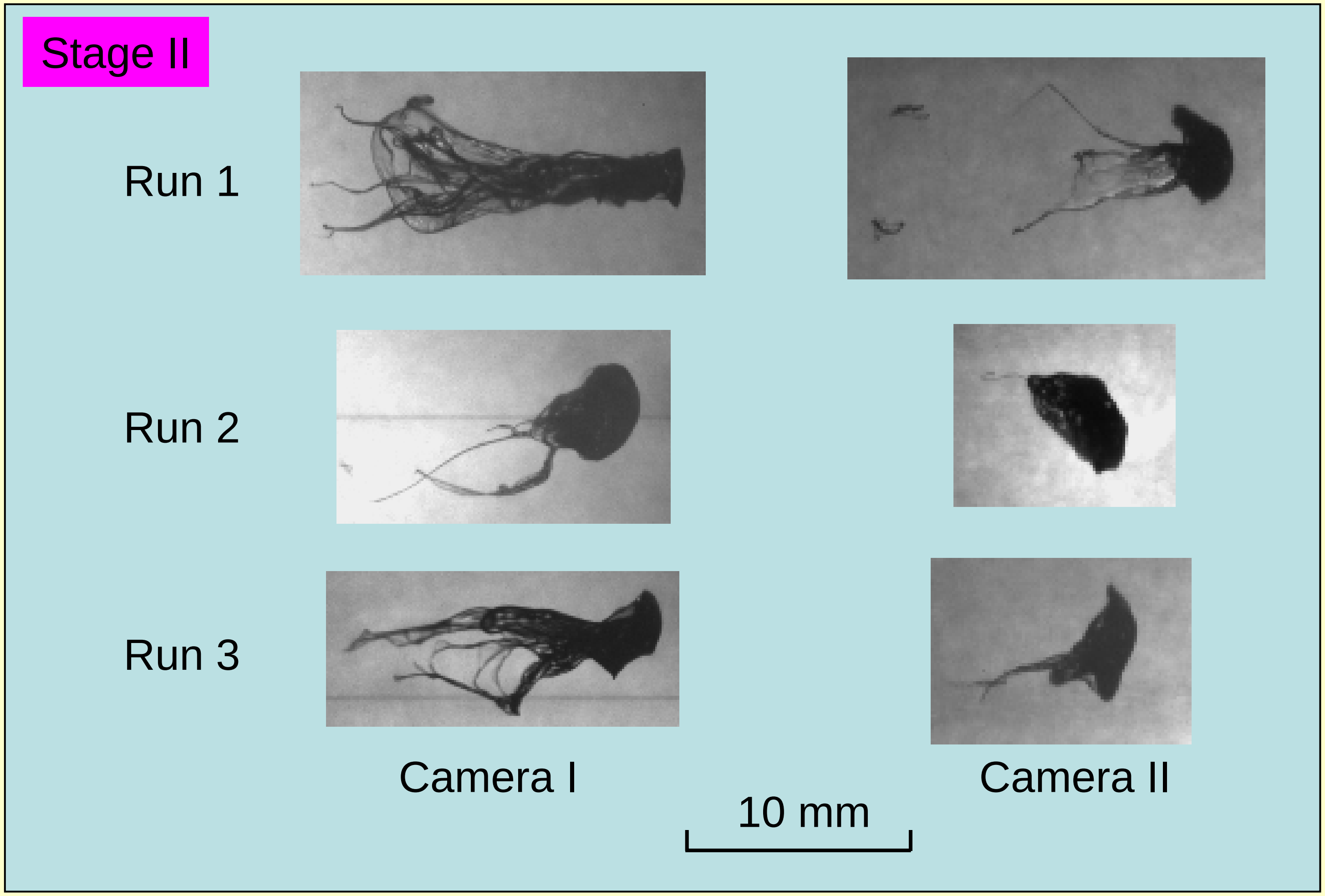
3.8%PSBMA+TBP

***d* = 3.4 mm, *We*=29,000**

Breakup History at the Dynamic Pressure of 10^4 Pa

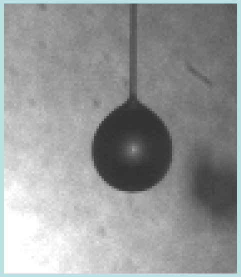


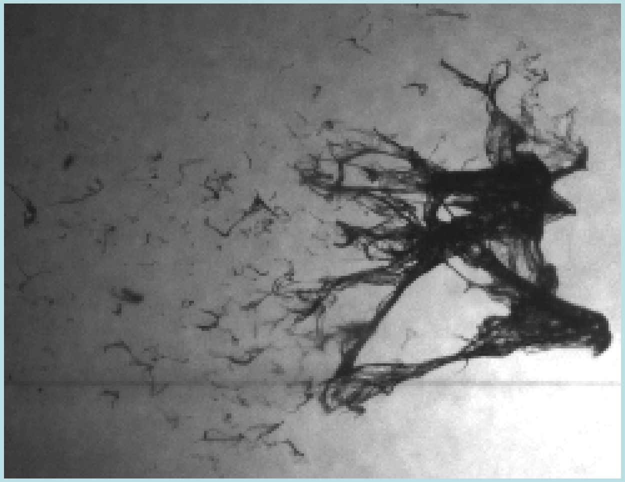
Breakup History at the Dynamic Pressure of 10^4 Pa



Breakup History of a Polymeric drop at the dynamic pressure of 10^5 Pa

Stage I



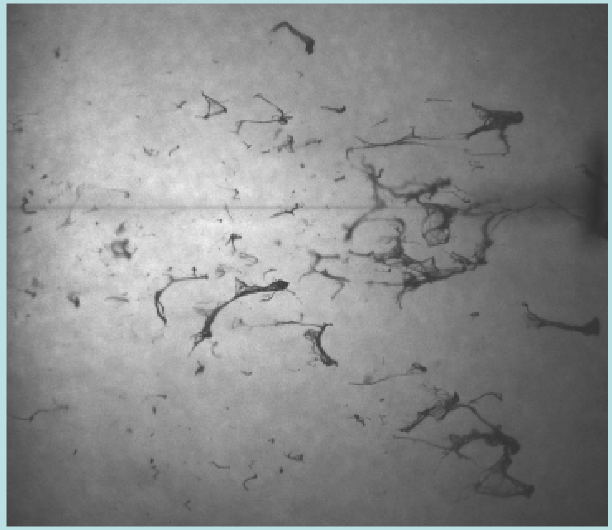


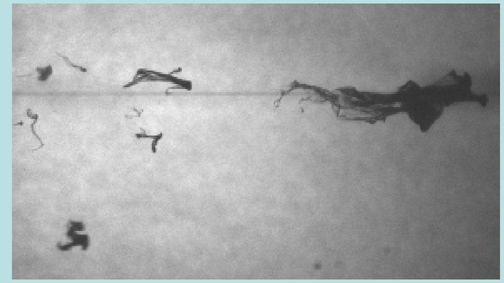
10 mm

Breakup History at Dynamic Pressure of 10^5 Pa

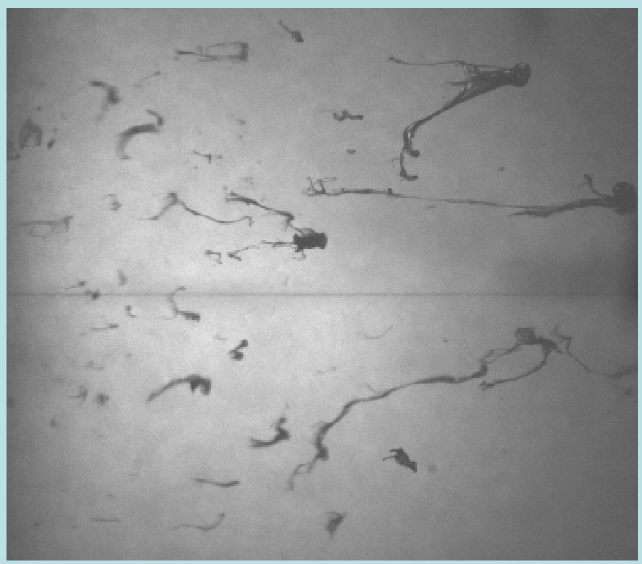
Stage II

Run 2

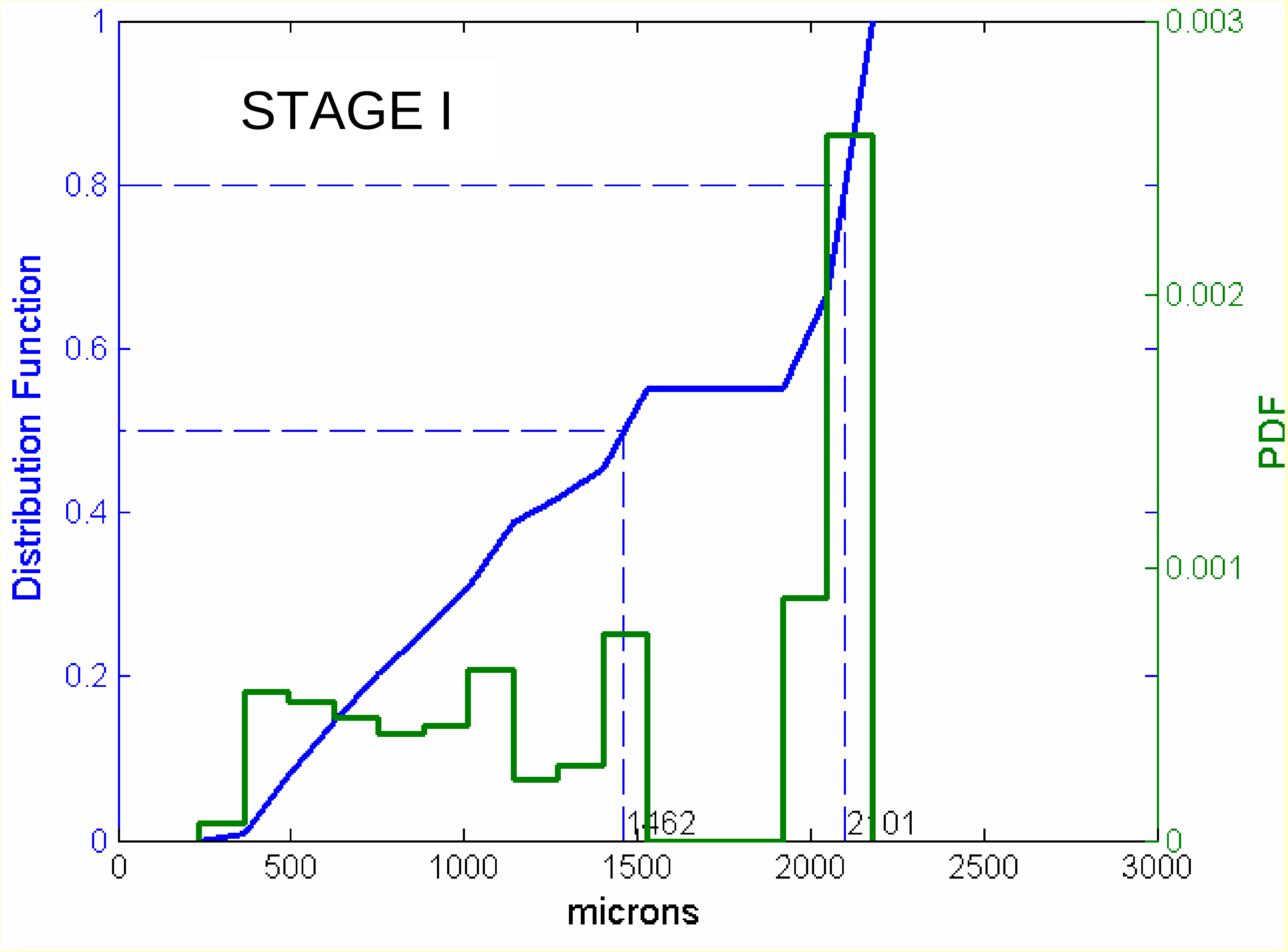




Run 3



10 mm



STAGE I
Distribution Function
PDF
microns
1
0.8
0.6
0.4
0.2
0
0.003
0.002
0.001
0
0
500
1000
1500
2000
2500
3000
1462
2101

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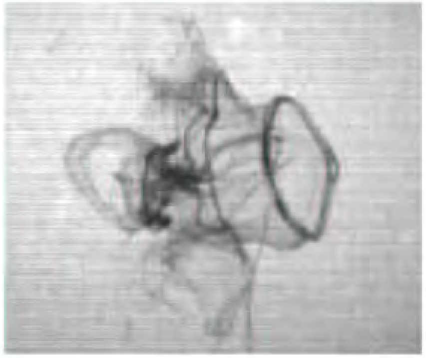
R
T
P



We=28, d=3.8mm, P_0=15pa

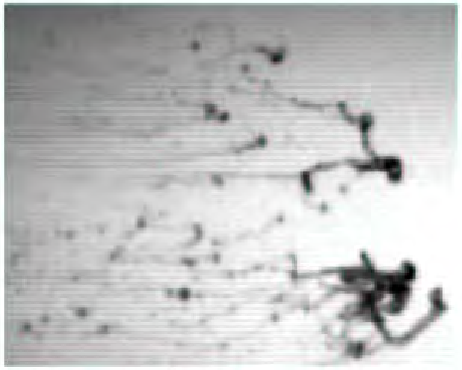
2

We=44, d=3.7mm, P_0=23pa

3

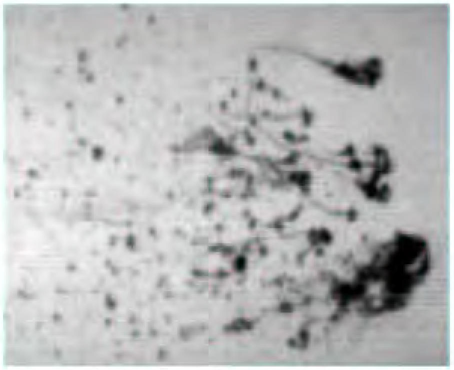
We=56, d=3.7mm, P_0=30pa

4



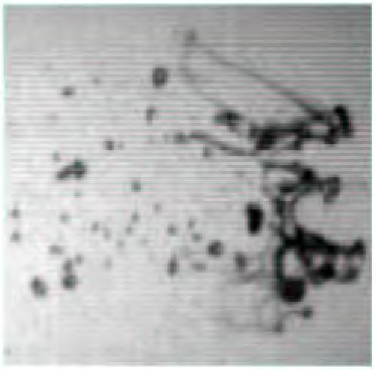
We=58, d=3.7mm, P_0=31pa

2-3



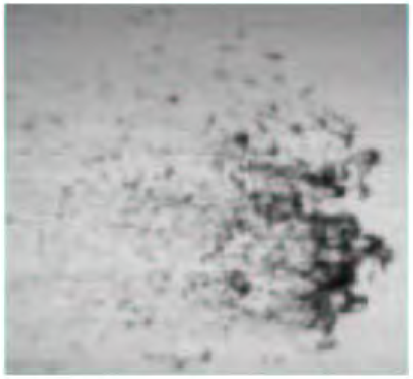
We=63, d=3.7mm, P_0=35pa

3



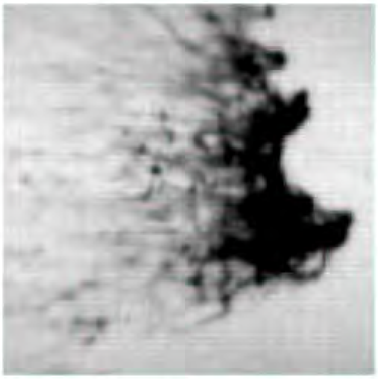
We=68, d=3.7mm, P_0=37pa

3-4



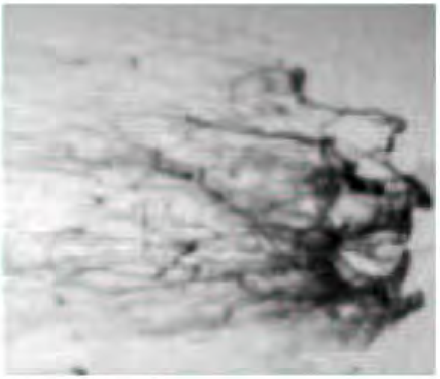
We=109, d=3.9mm, P_0=55pa

4-5



We=183, d=3.7mm, P_0=100pa

4-5

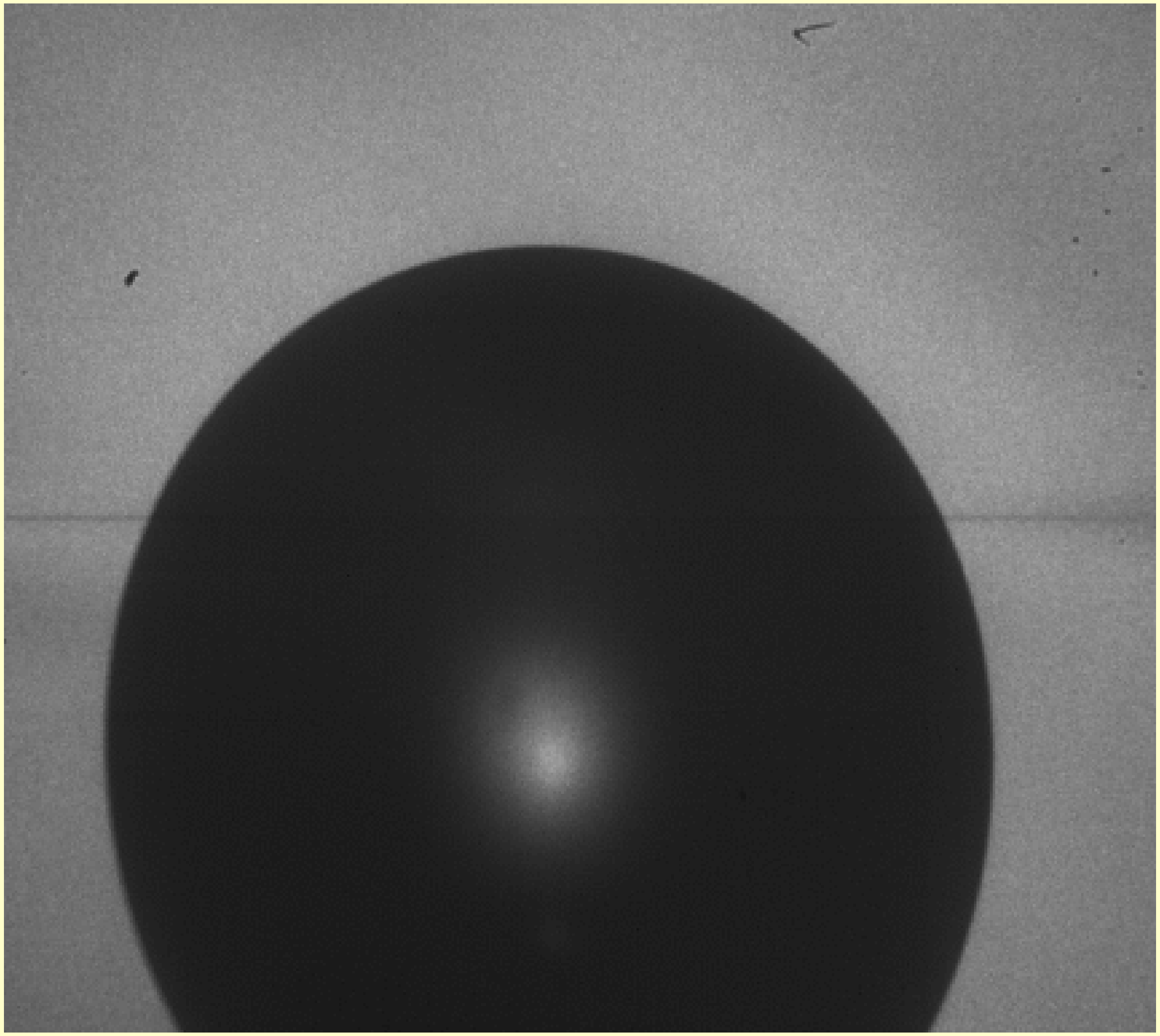


We=299, d=3.7mm, P_0=160pa

9

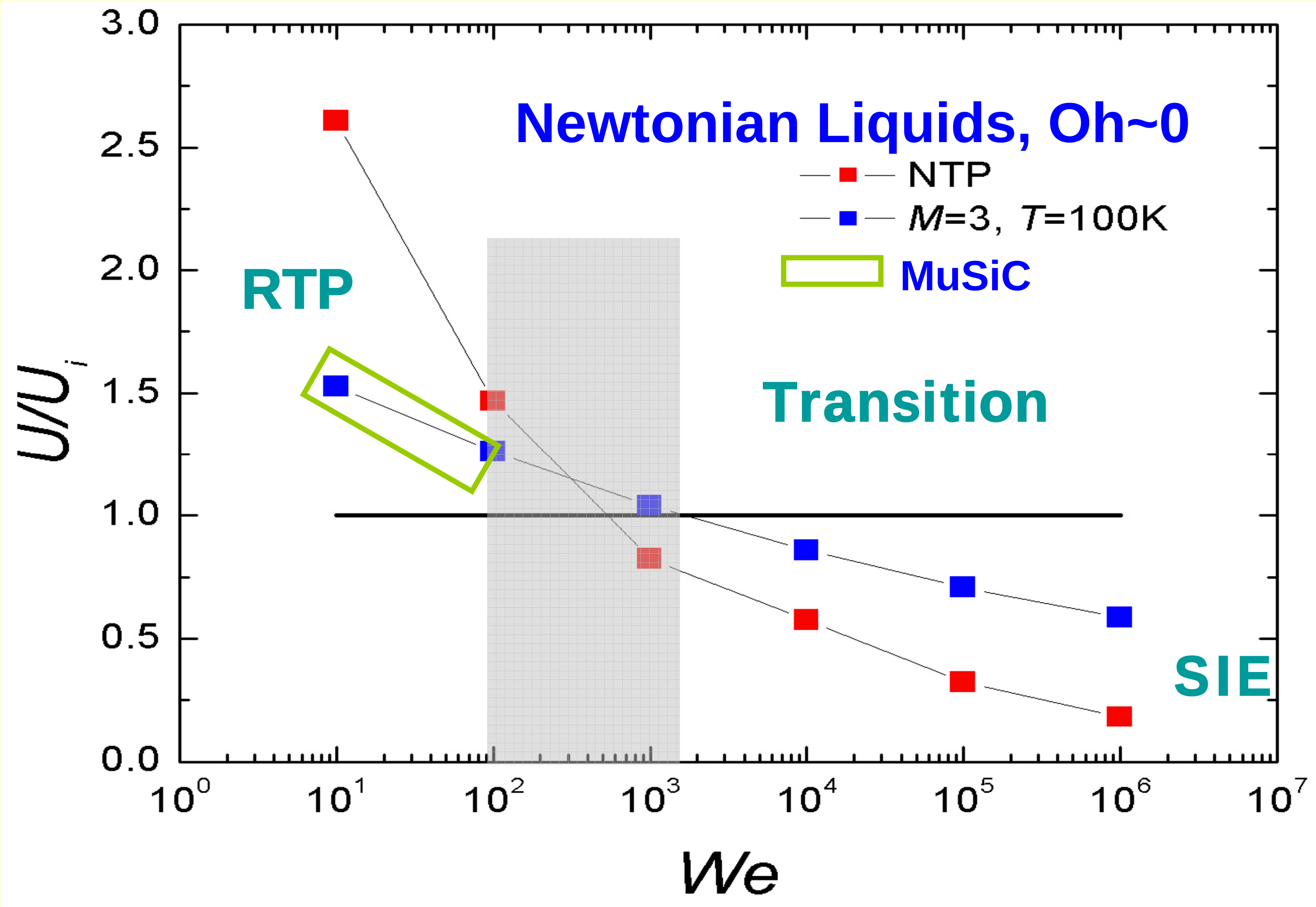
Close-up of a TBP drop at Dynamic Pressure of 10^5 Pa

S
I
E



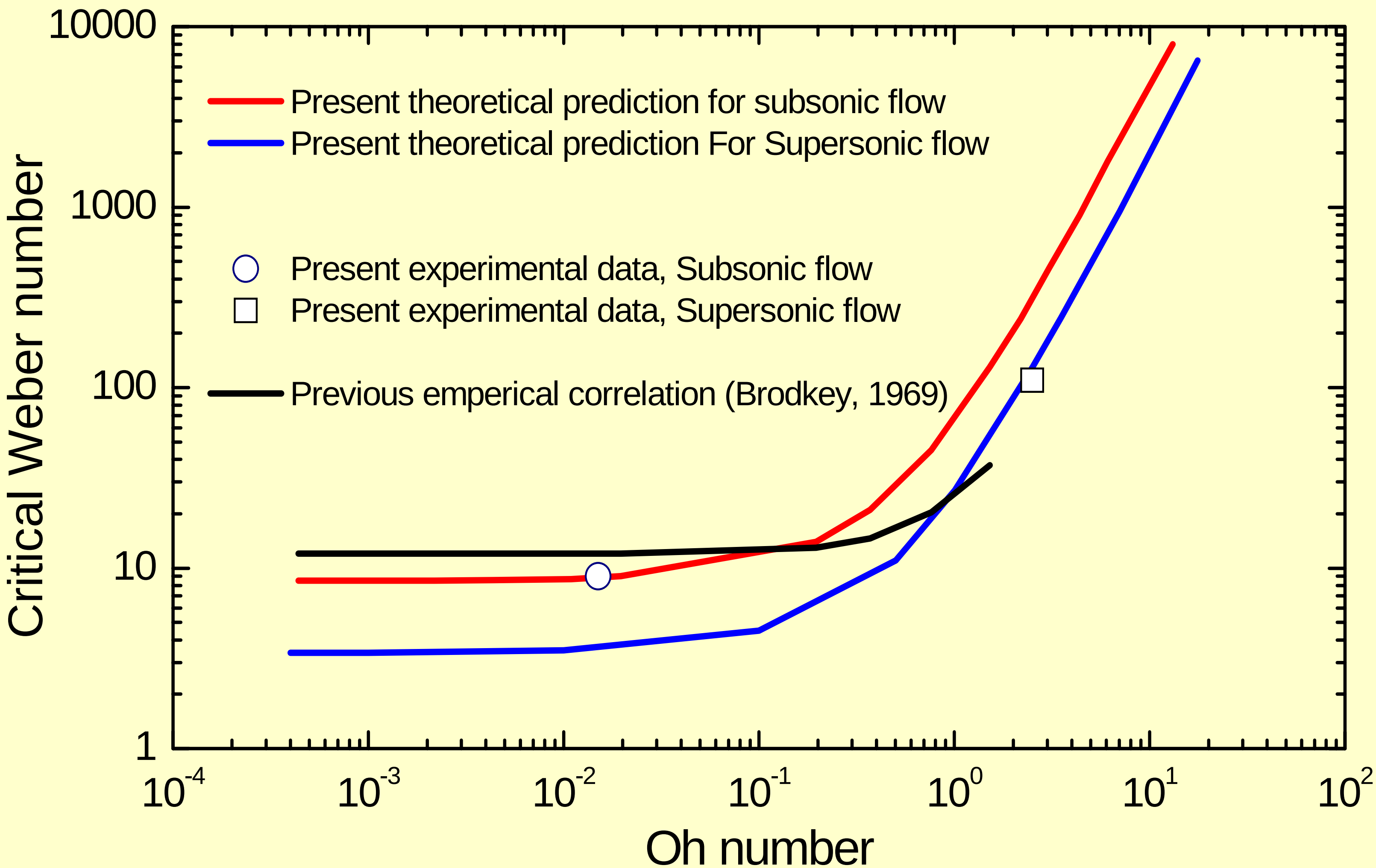
TBP drop, d=3.5 mm, We=31,000
(Movie) Frame-frame time interval=80 μs

We now have a Comprehensive Understanding of the Regimes of Aerobreakup for Newtonian Liquids



T.G.Theofanous, et al,,*ASME JFE*, 2004 and IUTAM Elsevier, 2006.

We now Understand how Viscous, Newtonian Liquids Break up.



Theory: Single Taylor Wave Penetration the Timing works out too.

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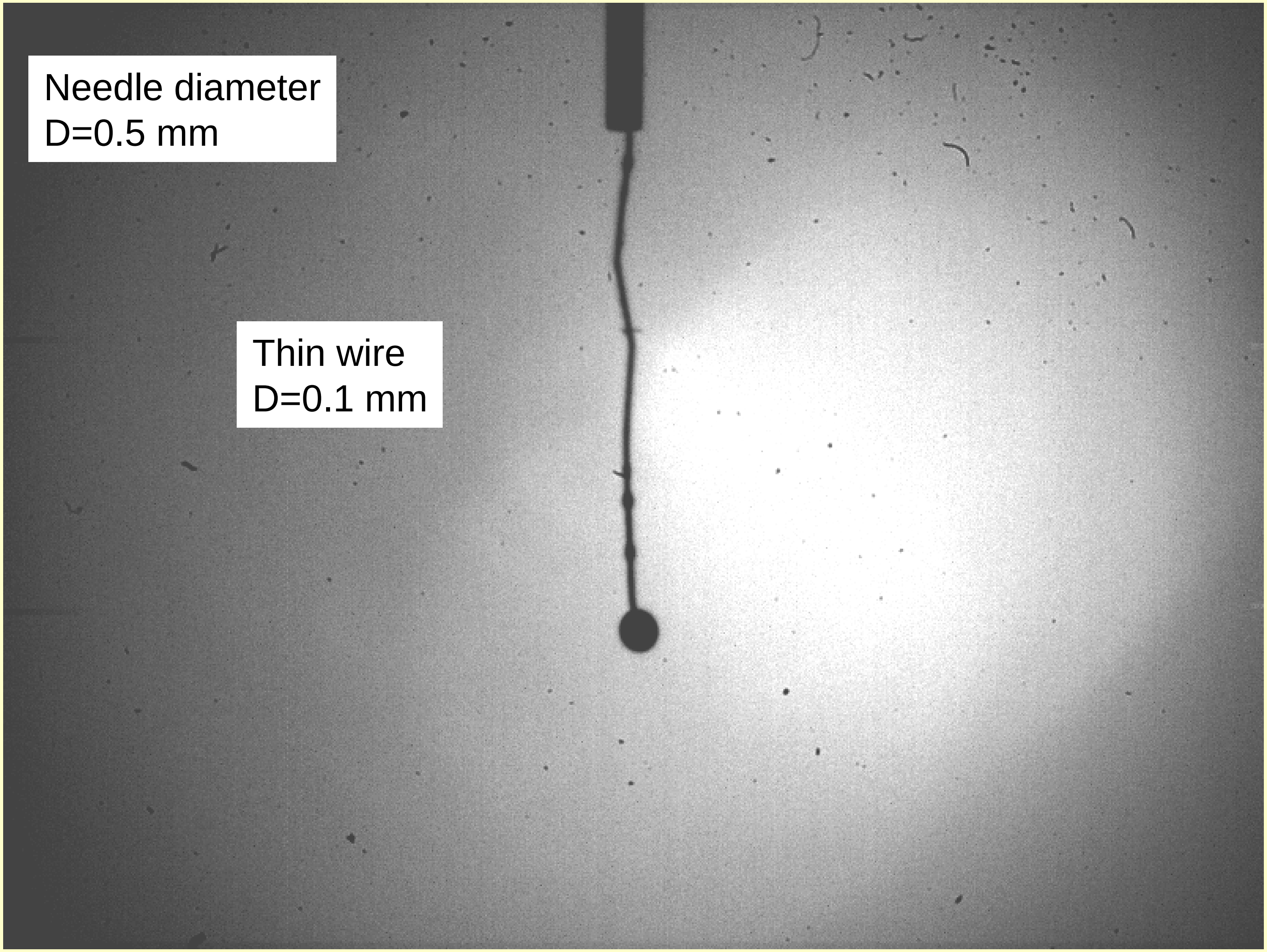
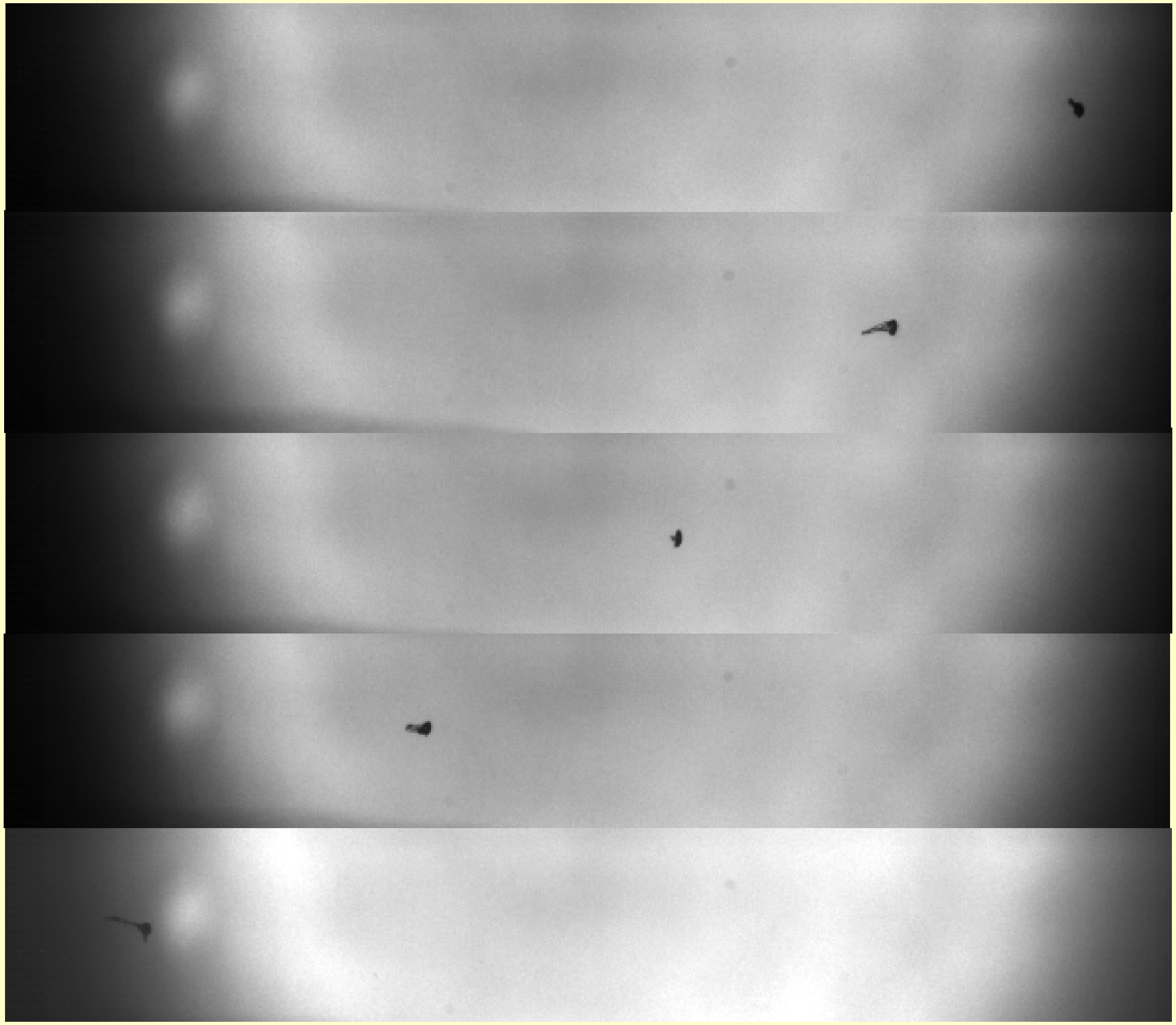
Drop Generator – Polymer Drop



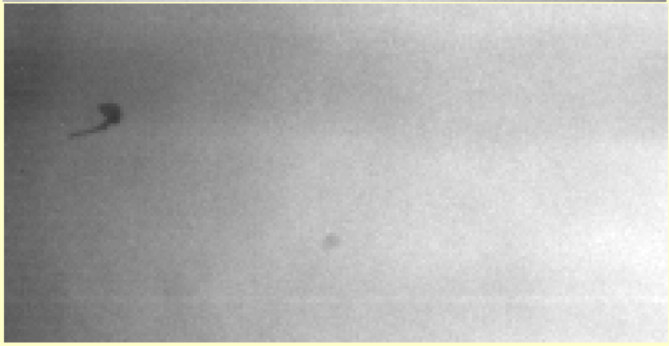
Polymer drop at We_0 = 4500



d=0.6 mm, Drop velocity V=200 m/s

Polymer drop at We_0= 4100 , 153mm Downstream

t = 1.175 ms



t = 1.254 ms

d=0.5 mm, Drop velocity V = 335 m/s,

$We = 0.21\ We_0$

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Delta-formulation

Transition from one fluid to another

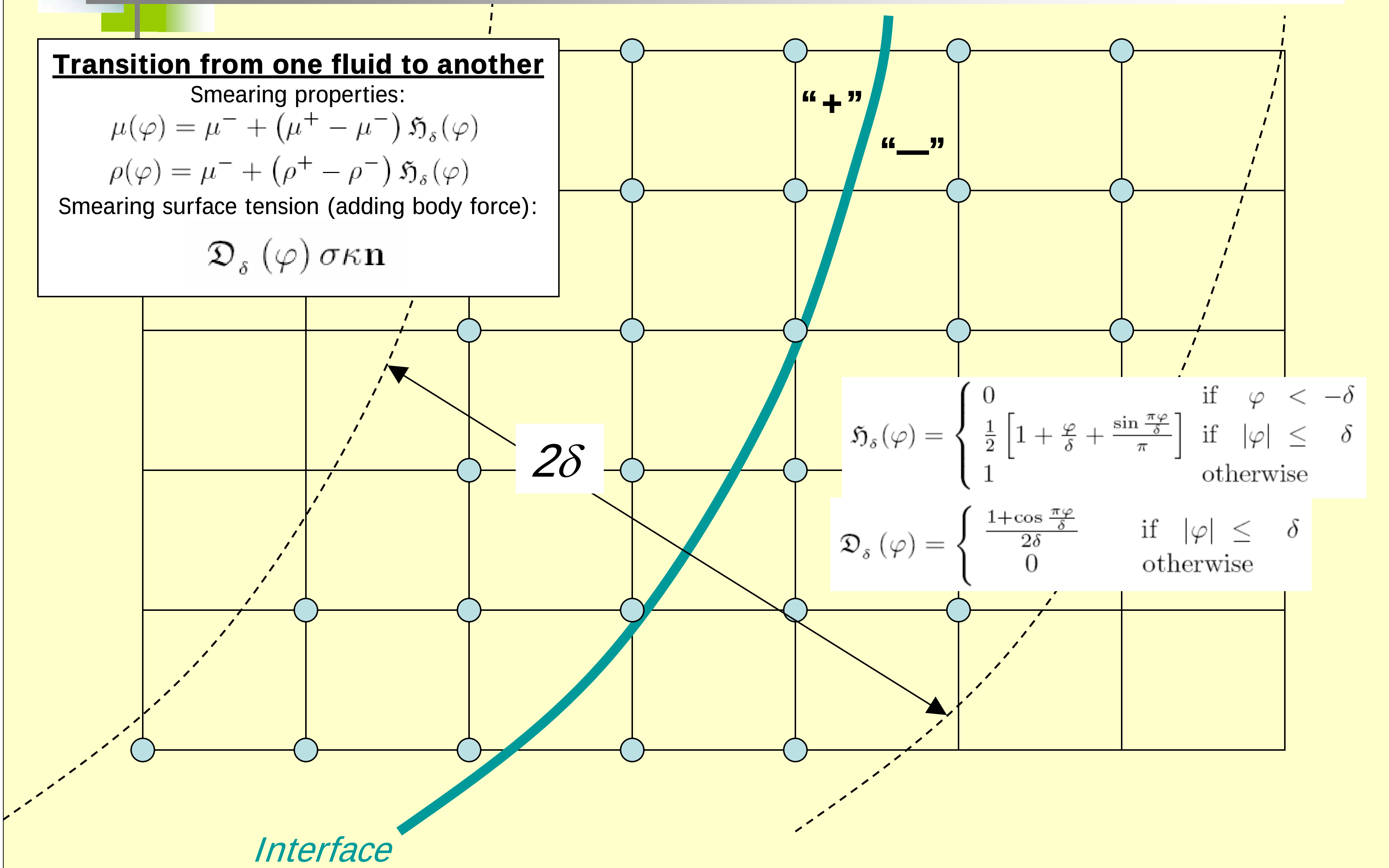
Smearing properties:

$$\mu(\varphi) = \mu^{-} + \left(\mu^{+} - \mu^{-}\right) \mathfrak{H}_{\delta}(\varphi)$$

$$\rho(\varphi) = \mu^{-} + \left(\rho^{+} - \rho^{-}\right) \mathfrak{H}_{\delta}(\varphi)$$

Smearing surface tension (adding body force):

$$\mathfrak{D}_{\delta}\left(\varphi\right) \sigma \kappa \mathbf{n}$$



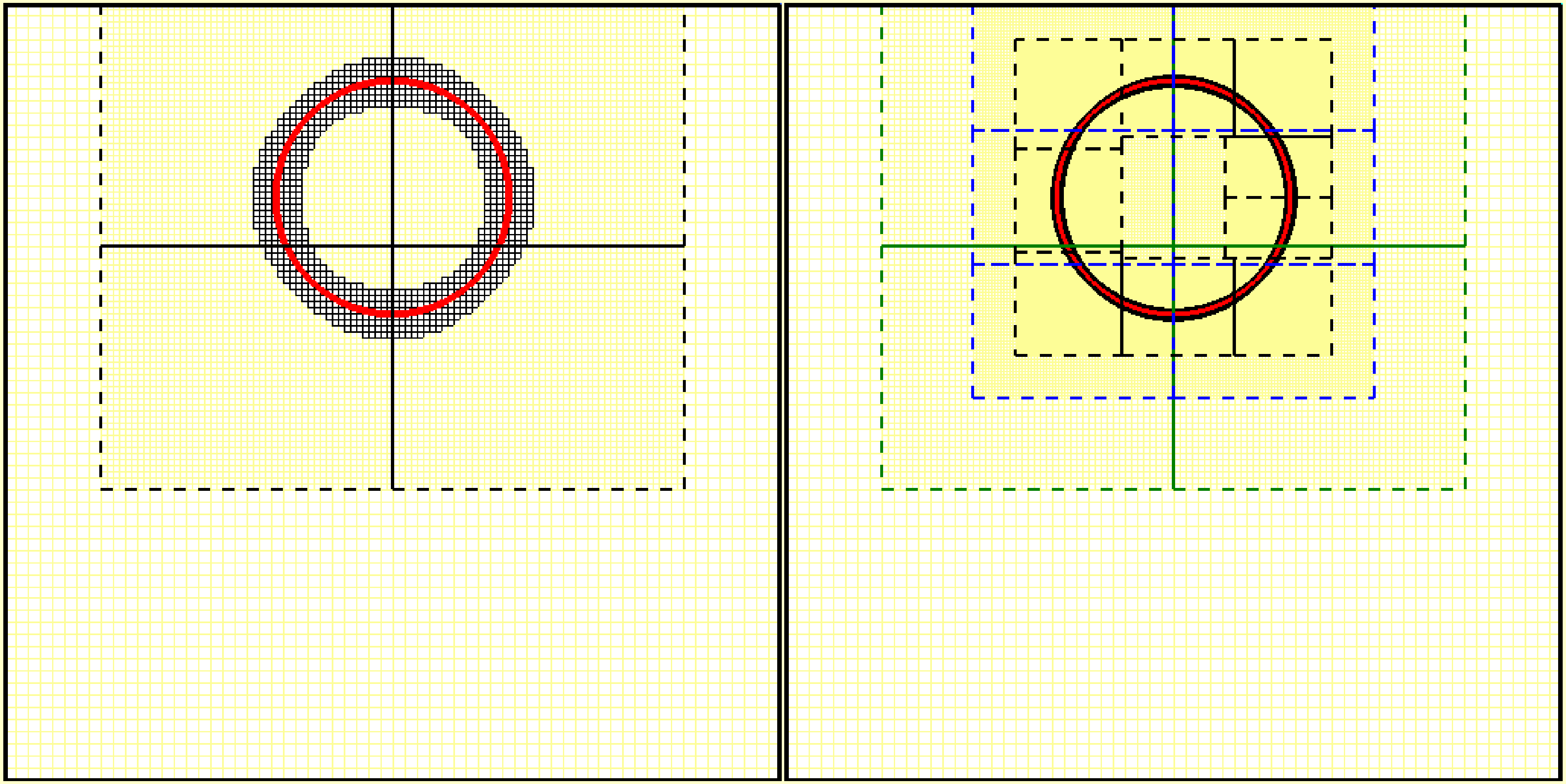
$$\mathfrak{H}_{\delta}(\varphi) = \begin{cases} 0 & \text{if} \quad \varphi \; < \; -\delta \\ \frac{1}{2}\left[1 + \frac{\varphi}{\delta} + \frac{\sin\frac{\pi\varphi}{\delta}}{\pi}\right] & \text{if} \quad |\varphi| \; \leq \; \delta \\ 1 & \text{otherwise} \end{cases}$$

$$\mathfrak{D}_{\delta}\left(\varphi\right) = \begin{cases} \frac{1+\cos\frac{\pi\varphi}{\delta}}{2\delta} & \text{if} \quad |\varphi| \; \leq \; \delta \\ 0 & \text{otherwise} \end{cases}$$

I. aC^3MR

Single Vortex

2 AMR levels: 128^2 4 AMR levels: 512^2 (8 processors)

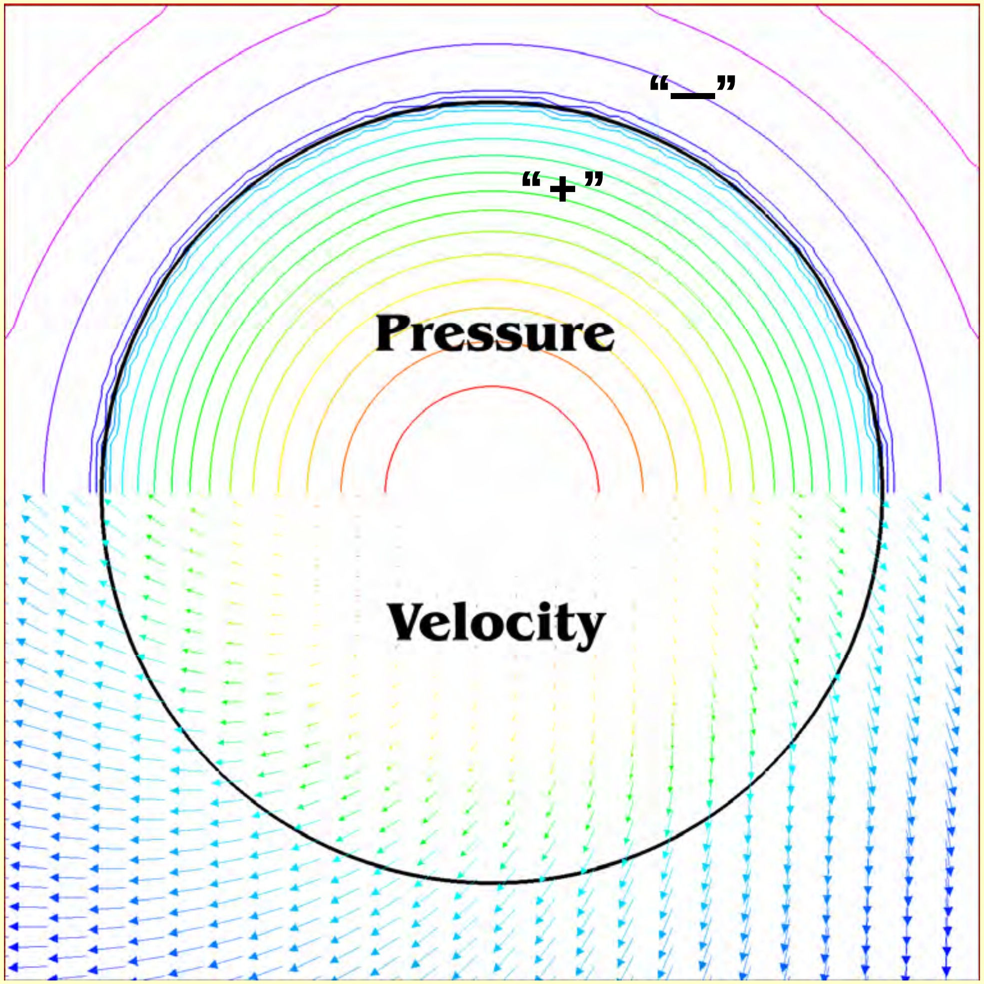


High-resolution simulations

ac³MR

V. Sharp Reconstruction (SR) of interface jump conditions

Grid convergence test



Exact solution:

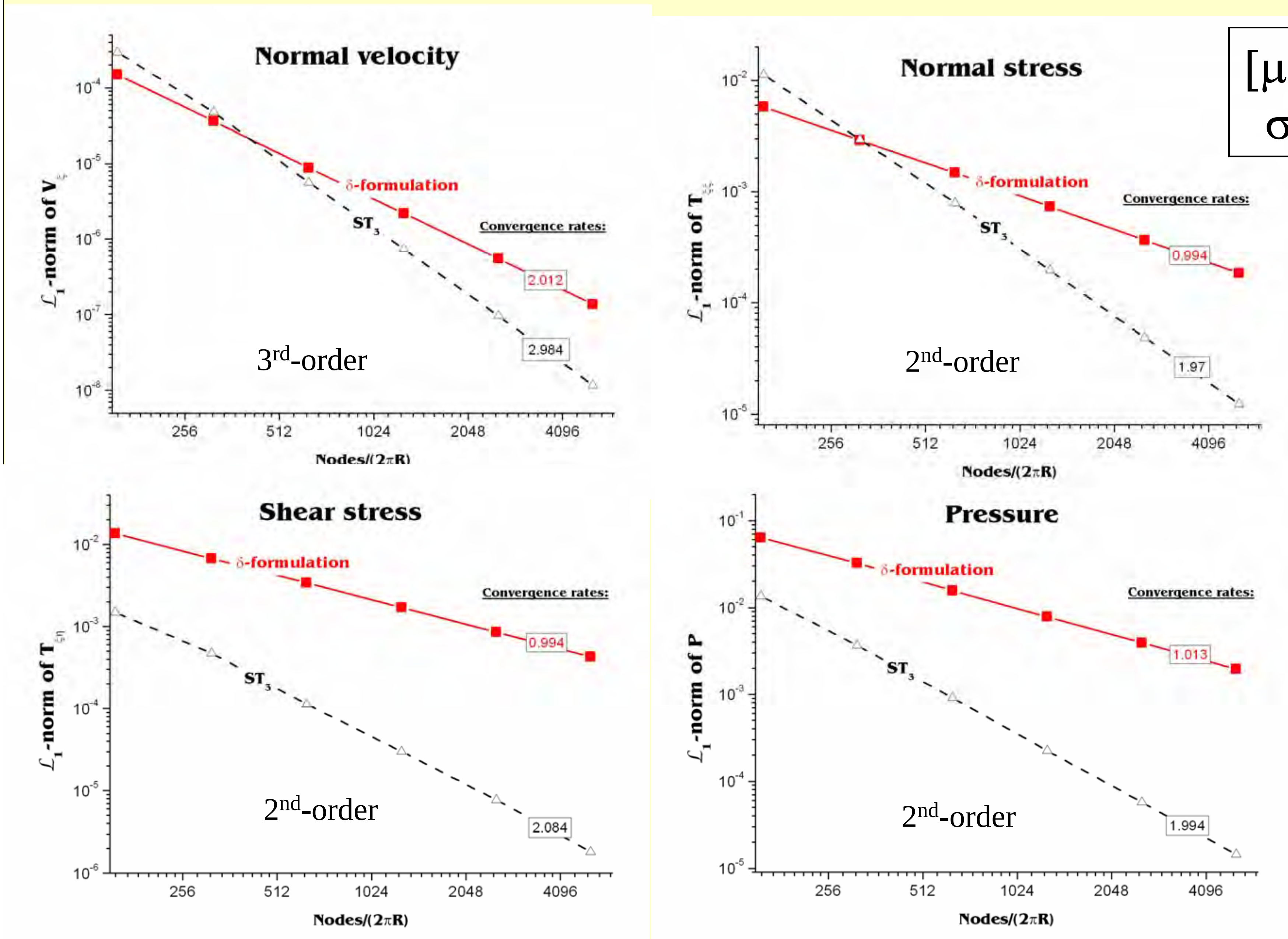
$$
\begin{aligned}
P^+(r) &= P_0 + \left(P_I^+ - P_0\right)\left(\tfrac{r}{R}\right)^2 \\
V_\xi^+(r) &= V_{\xi_I}\left(\tfrac{r}{R}\right)^2 \\
V_\eta^+(r) &= V_{\eta_I}\left(\tfrac{r}{R}\right)^3
\end{aligned}
$$

$$
\begin{aligned}
P^-(r) &= P_I^- \frac{R}{r} \\
V_\xi^-(r) &= V_{\xi_I}\left(1 - 2\langle\mu\rangle \tfrac{r}{R}\left(1 - \tfrac{r}{R}\right)\right) \\
V_\eta^-(r) &= V_{\eta_I}\left(1 - 3\langle\mu\rangle\left(1 - \tfrac{r}{R}\right)\right)
\end{aligned}
$$

where $P_0 = 20,\ P_I^+ = 10,\ P_I^- = P_I^+ - \frac{\sigma}{R},\ \sigma = 1,\ V_{\xi_I} = 1,\ V_{\eta_I} = 1$

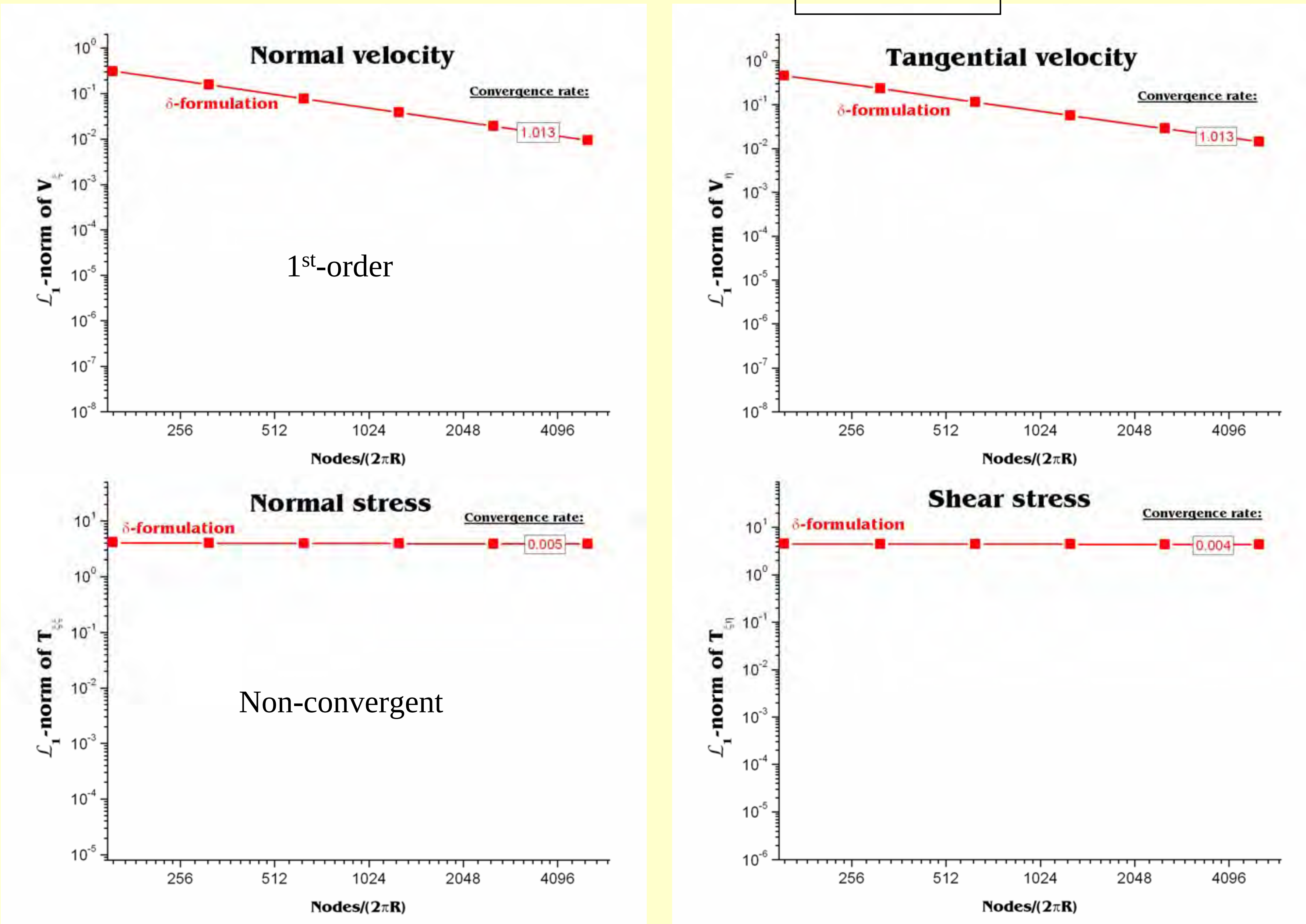
Grid convergence test

$$[\mu] = 0 \quad \sigma = 0$$



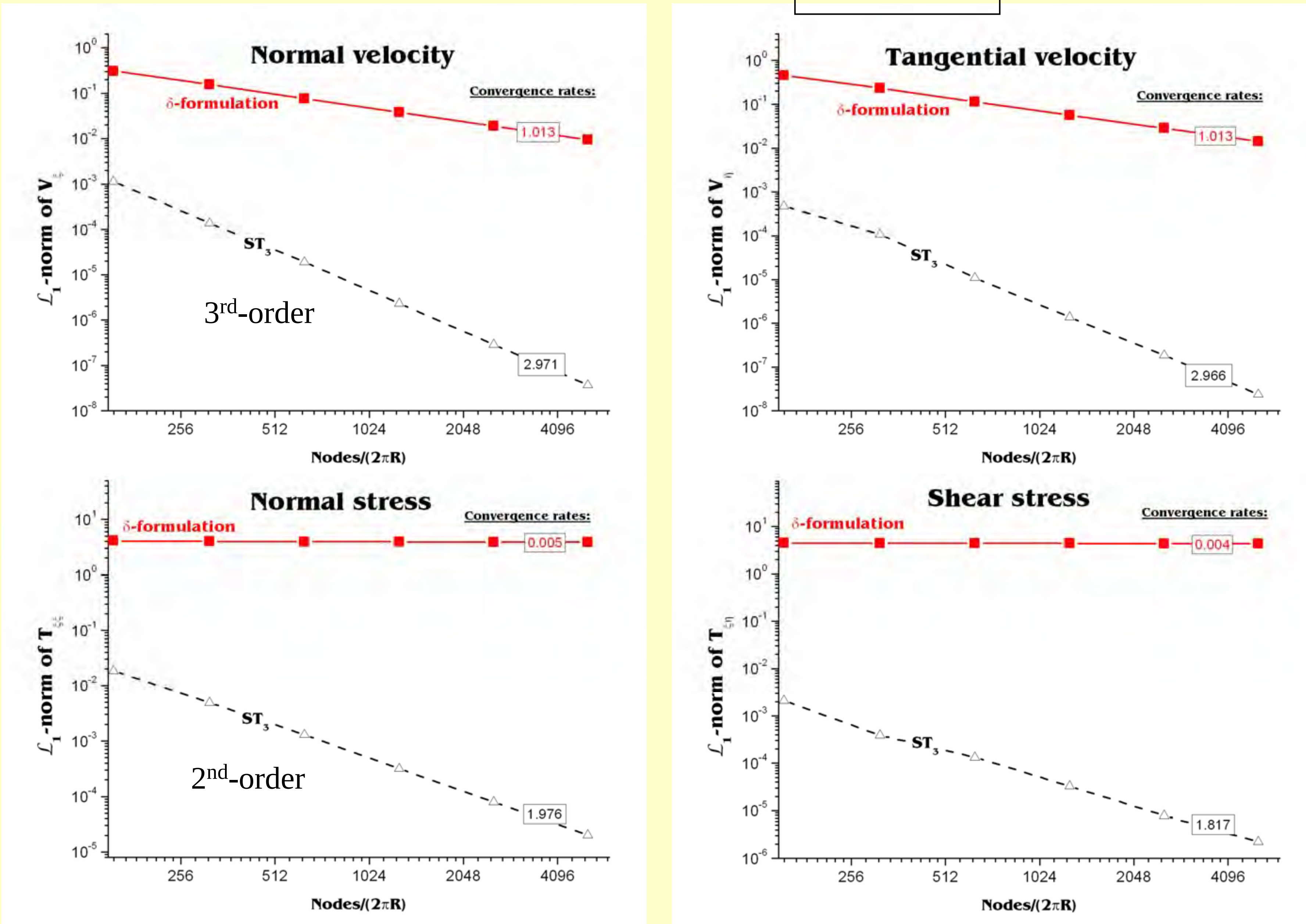
Grid convergence test

$\langle\mu\rangle = 25$
$\sigma = 1$

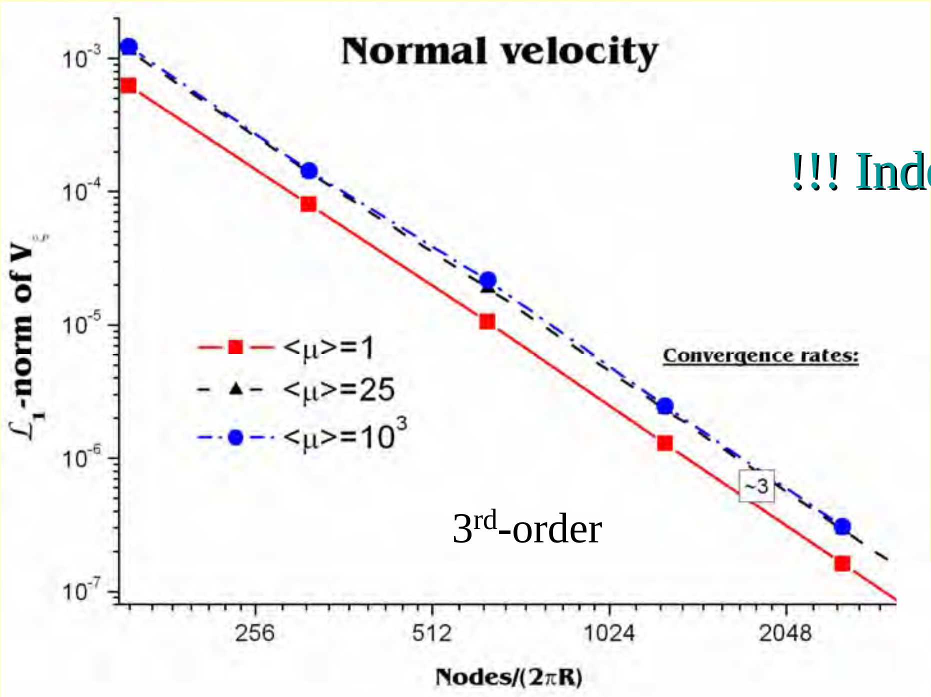


Grid convergence test

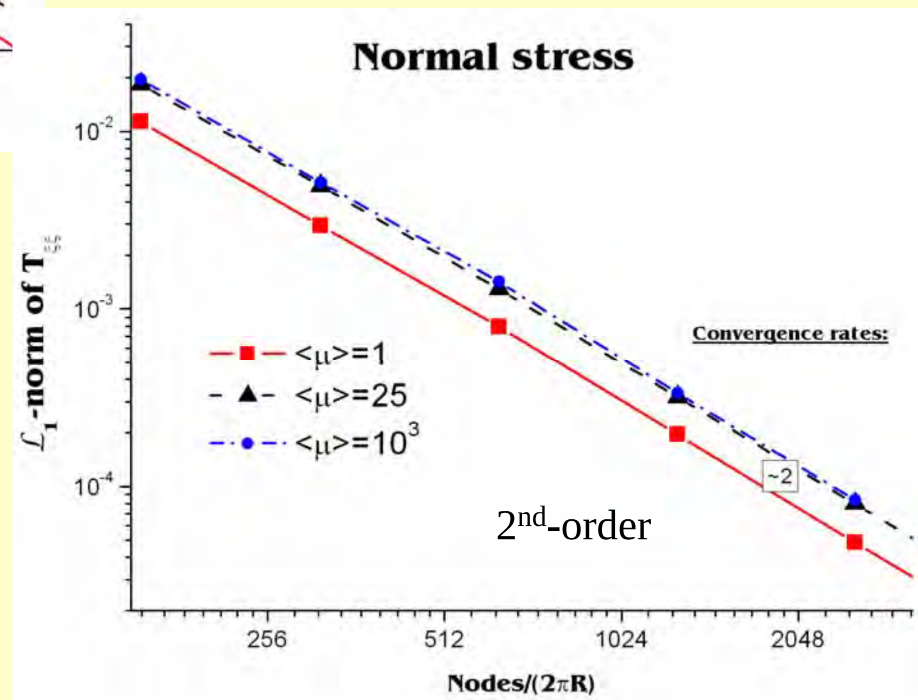
$\langle\mu\rangle = 25$
$\sigma = 1$



Grid convergence test



!!! Independent of viscosity ratio !!!



Major Results

- On Data Base development we have proven all aspects of the experimental technique and begun Production Runs (well ahead of schedule),
- We have shown experimentally that VE drops can survive intact at We~ 4,000! Or $1/2\rho v^2 = 2\ 10^5$!
- We developed a theoretical understanding of the mechanisms for Newtonian/Viscous liquid breakup over the whole range of regimes, unified all data, and corrected major, long-standing misconceptions,
- On DNS we achieved the sharp treatment of interfaces, and established capability to compute instabilities on shocked, high acoustic impedance mismatch interfaces.

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Science and Technology for Chem-Bio Information Systems (S&T CBIS) Conference, 25-28 October 2005, Albuquerque, New Mexico

Proposed Translation of Joint Effects Model (JEM) Accuracy Requirement Into a Measurable Acceptability Criterion

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Introduction and Outline

- **Introduction**
  - Institute for Defense Analyses (IDA) is a non-profit research and development center, serving the Office of the Secretary of Defense, Defense Agencies, Unified Combatant Commands, and the Joint Staff.
  - For this task, IDA provides <u>independent</u> technical analyses to support hazard prediction model evaluation efforts
    - » sponsors have included: DTRA, DATSD NCB, MDA, JEM PMO, IDA CRP/PD
- **Outline of Presentation**
  - Joint Effects Model accuracy requirement
  - Issues with the application of this requirement to evaluations
  - Proposed solution
    - » user-oriented measure of effectiveness for hazard prediction models
    - » accuracy requirement interpreted as normalized absolute difference
  - Example results
  - Comments, caveats, summary

Joint Effects Model Accuracy Requirement

- **Mission Need**
  - "improved capability to portray chemical, biological, radiological, and nuclear (CBRN) effects in models and simulations…"
  - Joint MNS states, "…modeling and simulation does not adequately predict and track CBRN and Toxic Industrial Material (TIM) impact to support operational decisions and risk assessments."
- **Information Availability Requirement: Accuracy**
  - "JEM shall provide accuracy of ≥ 70%" threshold value (KPP)
    - » ≥ 85% objective
  - rationale states:"Accuracy ≥ 70% means that the error between the predicted and observed concentrations is no more than 30%"
- **Performance Requirement: Related to Accuracy**
  - JEM shall also predict hazard areas for CBRN and TIM events that reduce the likelihood of being Falsely Warned and Falsely Not Warned…"
  - rationale states: "For hazard prediction, operational risk management is a trade-off between the error of falsely warning personnel and the error of falsely not warning personnel."

***Operational Requirements Document for Joint Effects Model (JEM),* 28 May 2004.**

Issues With the Application of the Accuracy Requirement to Evaluations

- **Issue 1: typically not achievable or even reasonable**
  - For state-of-the-art models, differences between observed and predicted average concentrations will typically be larger than 70%, e.g.,
    - » ≤ 40% within a *factor of 2* for the very short range MUST field experiment
    - » "accuracy" was 71% for the short-range, open field *Prairie Grass* field experiment which included "unrealistically" detailed meteorological inputs
    - » accuracies of 68%, 57% and 45% for the 1997 OLAD field trial (3 models)
    - » for longer ranges and more realistic input conditions, accuracies would be expected to be worse
  - One proposal has been to compare predictions and observations of the maximum values only, regardless of their locations and then require that the Fractional Bias (fraction over- or under-prediction) be ≤ 0.3

- **Issue 2: not what the user actually wants, needs, or requires**
  - In general, users are not interested in average or maximum concentrations
  - Rather, for most applications (planning & warning), users are interested in the locations and times at which a hazardous condition exists (or might exist)

Hazard region (hazard area) predictions are desired.

Proposed Solution

- Evaluate hazard prediction with a user-oriented measure of effectiveness (MOE) that allows for assessments of how well the prediction and observation of hazardous region “overlap” in time and space

This allows one to do the evaluation in the “space” that is of interest to the user.

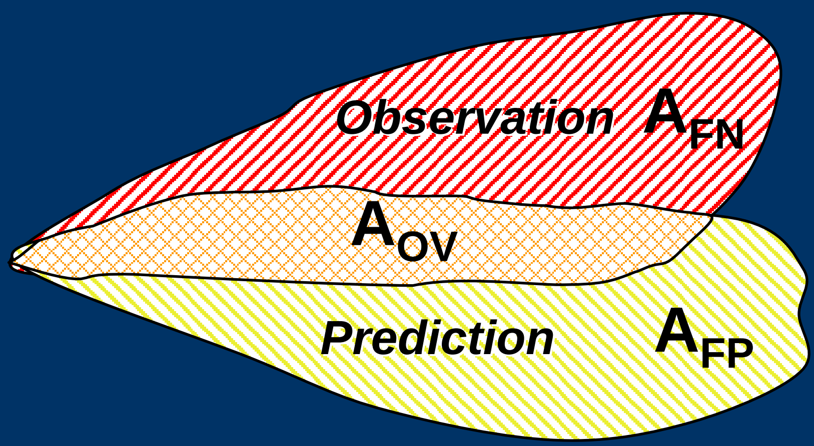
- Translate ORD accuracy requirement into an acceptability function – normalized absolute difference - that can be assessed based on the above MOE from field experiment observations and predictions

This allows the ORD accuracy requirement to be directly evaluated.

User-Oriented Two-Dimensional MOE Introduction

- **Fundamental feature of any comparison of model output to observations is over- and under-prediction**
  - False Negative (FN): hazard is observed but <u>not</u> predicted
  - False Positive (FP): hazard is predicted but <u>not</u> observed

These two "dimensions," FP and FN, define the space in which the user is most interested



A_{FN} = Region of False Negative

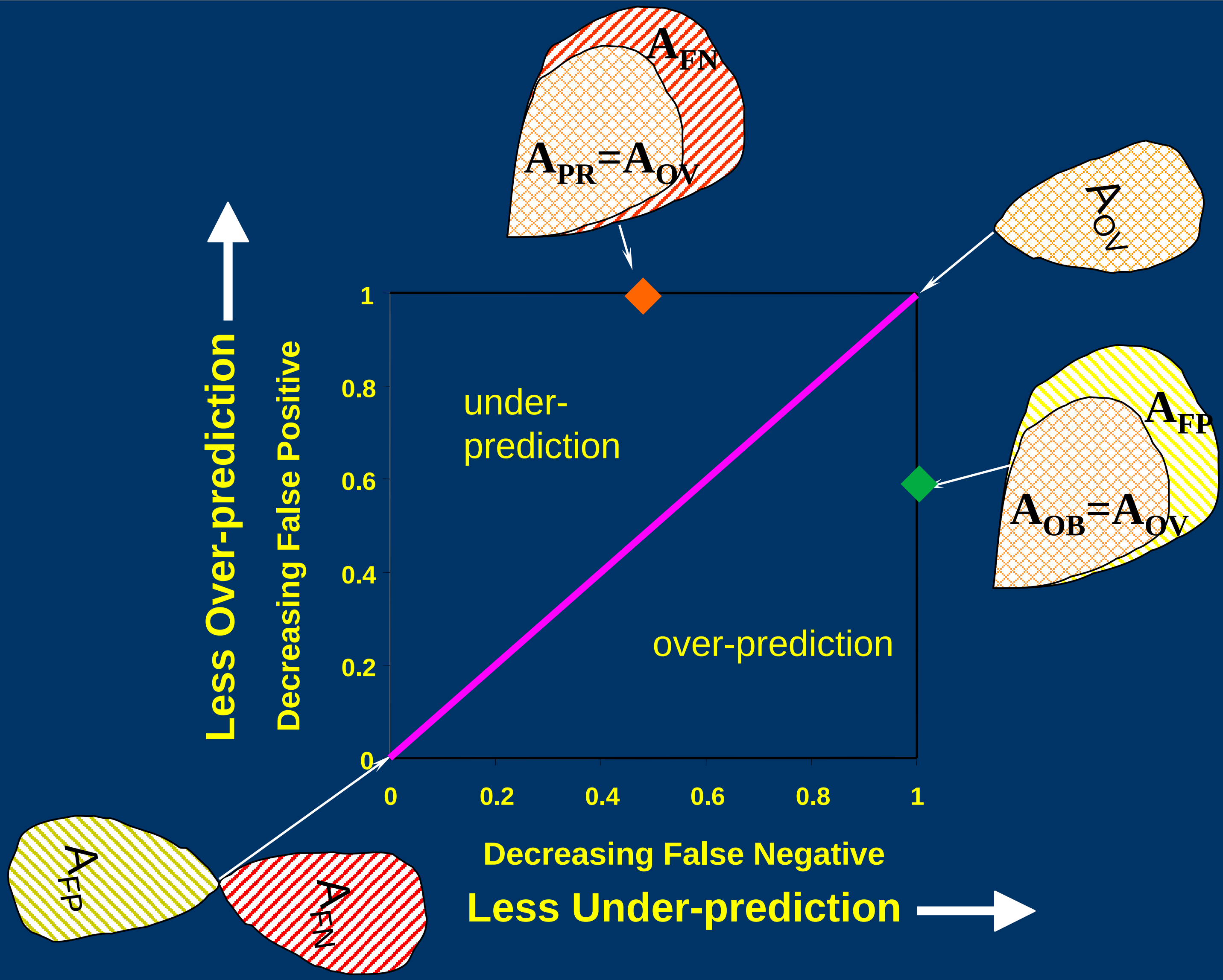
A_{OV} = Region of Overlap

A_{FP} = Region of False Positive

$A_{PR} = A_{OL} + A_{FP}$ = Region of Prediction

$A_{OB} = A_{OL} + A_{FN}$ = Region of Observation

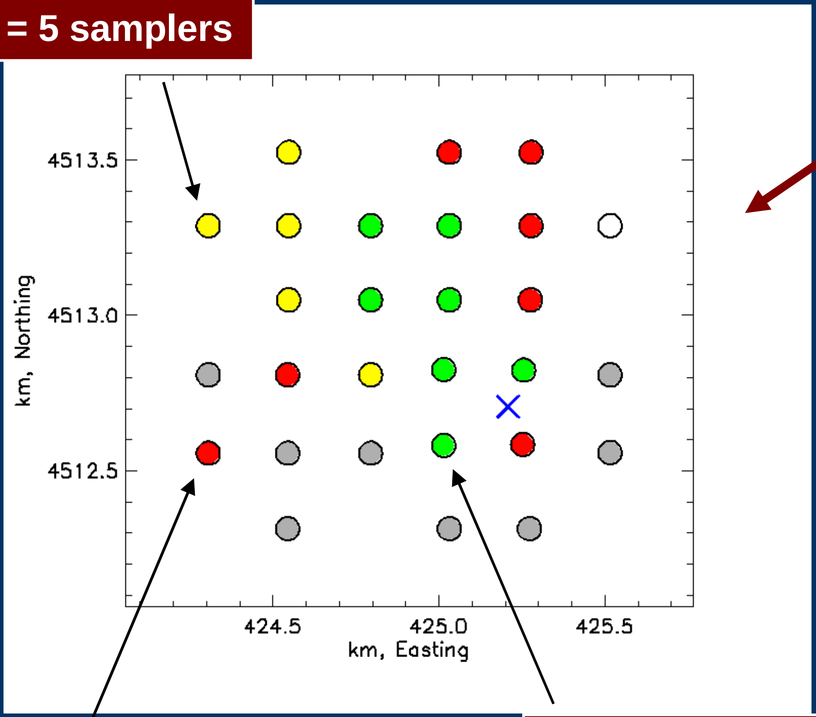
$$\mathrm{MOE} = \left(\frac{A_{OV}}{A_{OB}}, \frac{A_{OV}}{A_{PR}}\right) = \left(1 - \frac{A_{FN}}{A_{OB}}, 1 - \frac{A_{FP}}{A_{PR}}\right)$$



Sample MOE Component Calculation: *Urban 2000*, Downtown Salt Lake City

Illustration of MOE threshold-based computation

A_{FP} = 5 samplers



A_{OV} = 7 samplers

A_{FN} = 7 samplers

for a 30 ppt concentration threshold

MOE = (7/14, 7/12) = (0.50, 0.58)

Several applications of this MOE have been published and include transformations of the MOE to account for:

(1) area interpolation,
(2) the underlying population distribution, and
(3) the expected human effects of notional agents.

Also, "scoring functions" have been developed, published, and applied to evaluate hazard prediction models with field experiment observations.

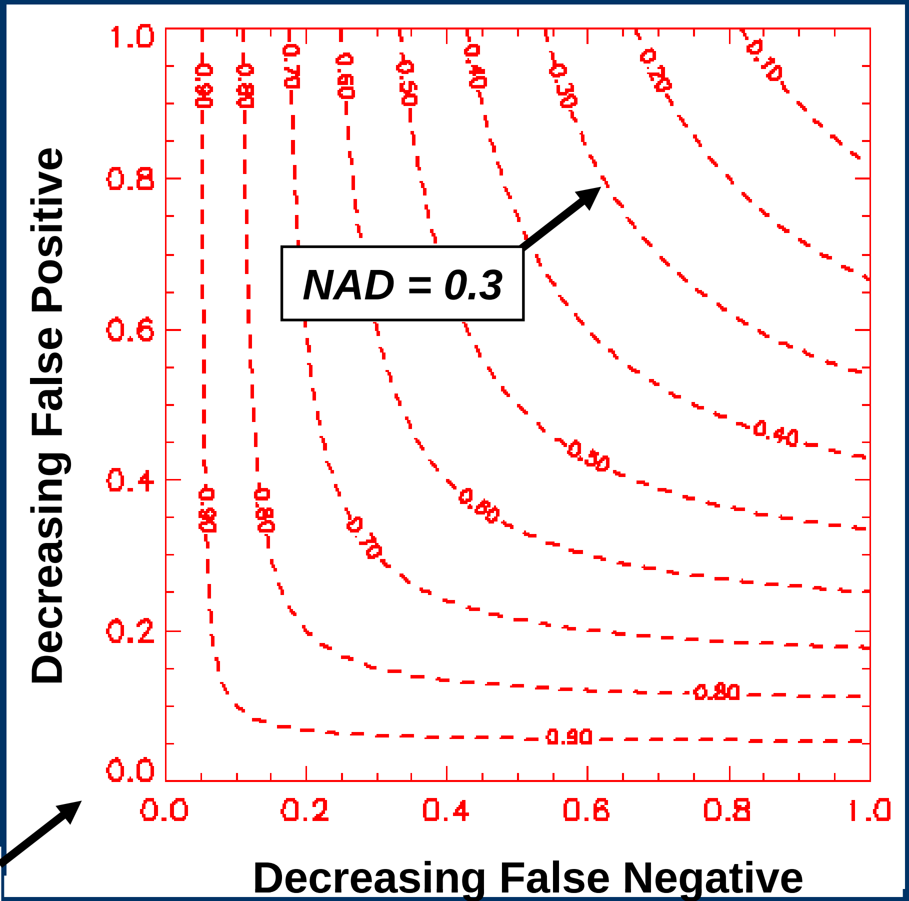
Accuracy ≡ Normalized Absolute Difference (NAD)

NAD ≤ 0.3 ⇒ Accuracy ≥ 70%

- For average concentration, NAD has previously been developed as a scoring function in the 2D MOE space

$$NAD = \frac{\sum_{i=1}^{n} \left| C_o^{(i)} - C_p^{(i)} \right|}{\sum_{i=1}^{n} \left(C_o^{(i)} + C_p^{(i)} \right)}$$

NAD = 0.0 ⇒ no scatter, perfect prediction



and, is related to the MOE(x,y) as

$$NAD = \frac{x + y - 2xy}{x + y}$$

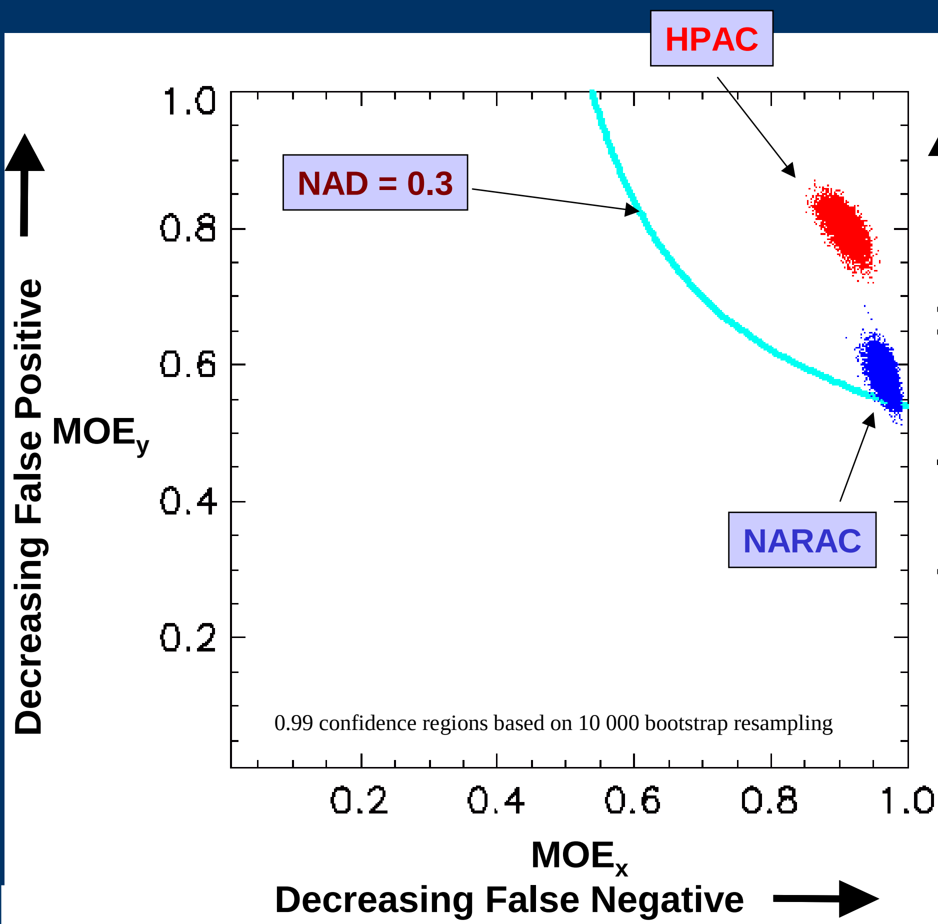
Isolines of NAD in the 2D MOE Space

But User is Interested in the Accuracy of Predicting Hazard Regions, Not Average Concentrations

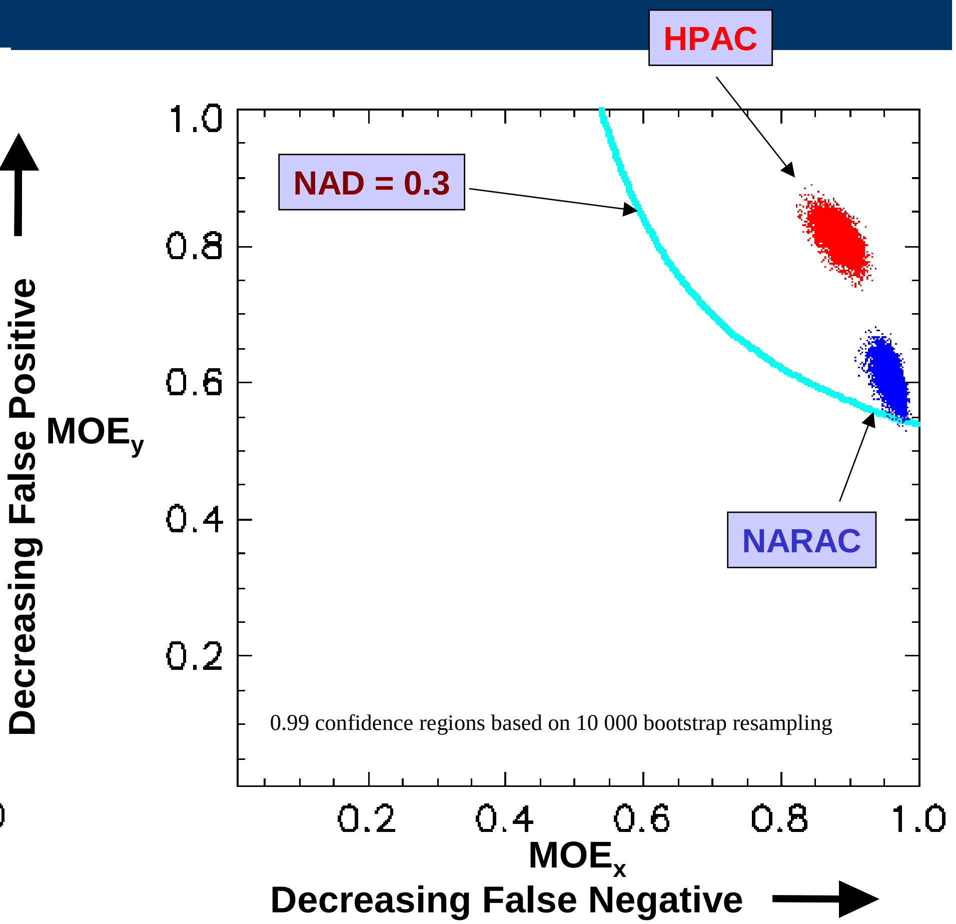
- **User's typical interest is in locations (times) where a hazard threshold is exceeded – a "hazard area"**
- **Fortunately, NAD can also be computed based on a threshold just like the MOE**
- **For the previous *Urban 2000* example, NAD = 0.46 implying an "accuracy" of predicting the downtown locations of the low-level hazard of 54%**

Example Application 1a: HPAC, NARAC, and the *Prairie Grass* Field Experiment

Threshold (T) = 15 mg sec m^{-3} ≈ 5 × sampler limit



T = 60 mg sec m^{-3} ≈ 20 × sampler limit

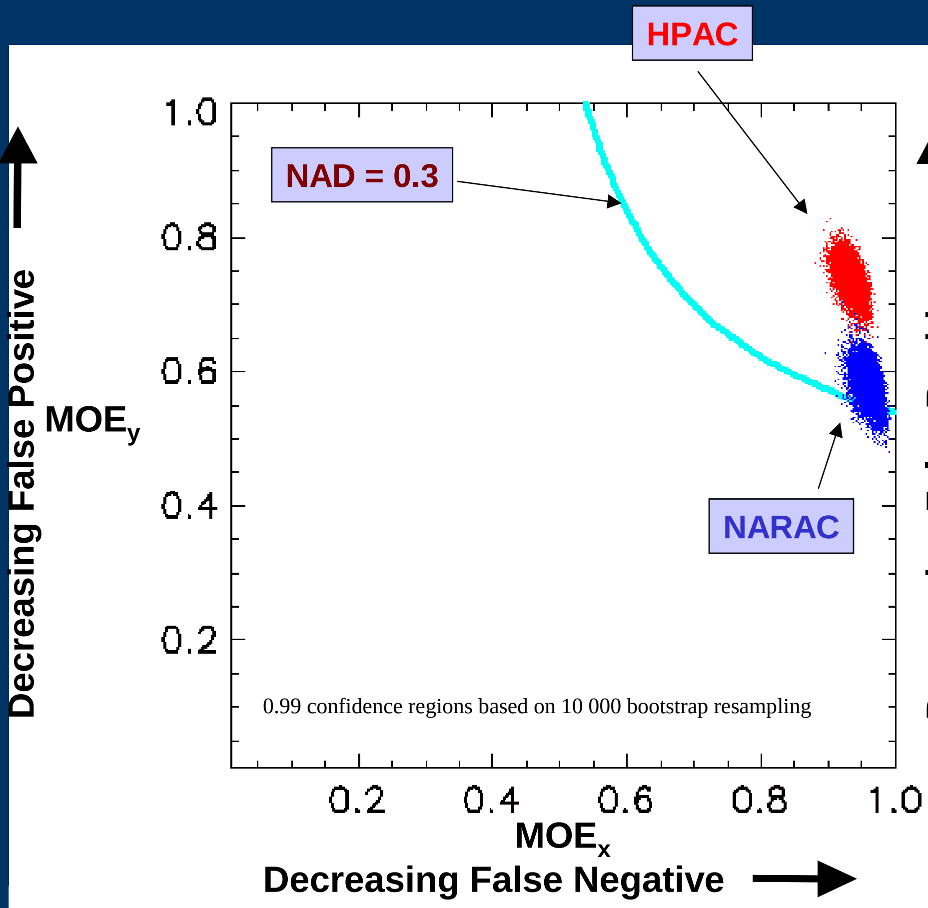


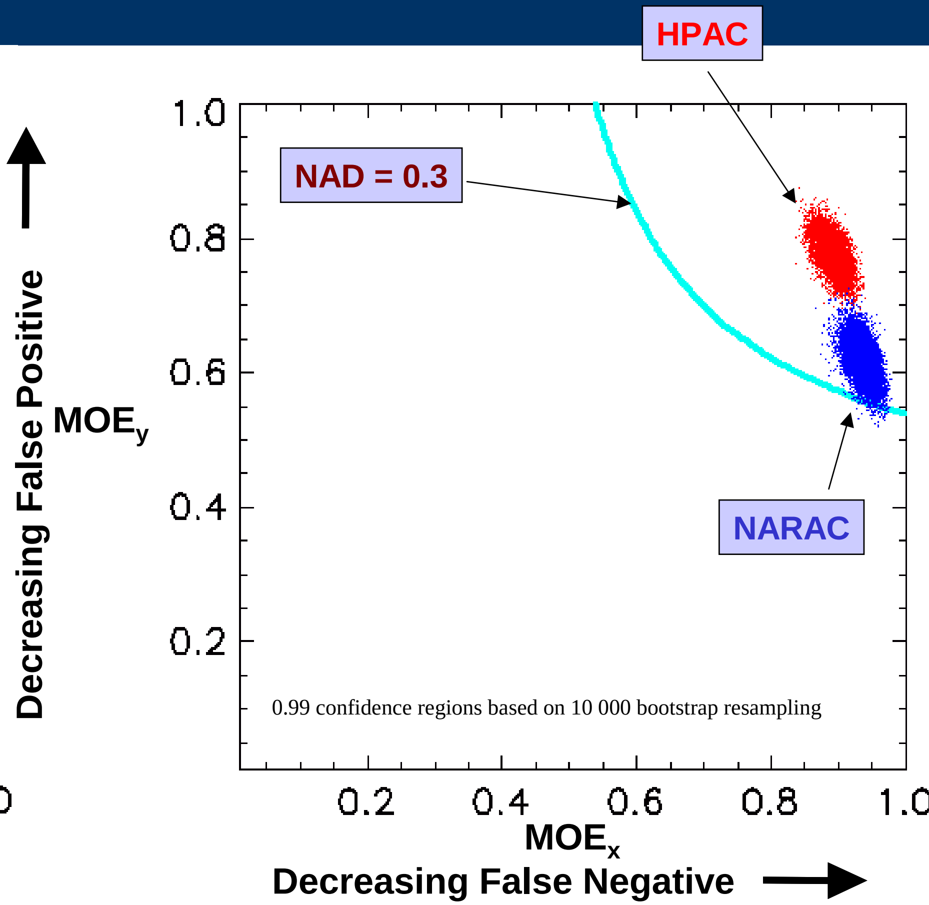
based on 51 releases

Example Application 1b: HPAC, NARAC, and the *Prairie Grass* Field Experiment After Area Interpolation – i.e., MOE components are based on real areas (km^2)

T = 15 mg sec m^{-3}
≈ 5 × sampler limit

T = 60 mg sec m^{-3}
≈ 20 × sampler limit



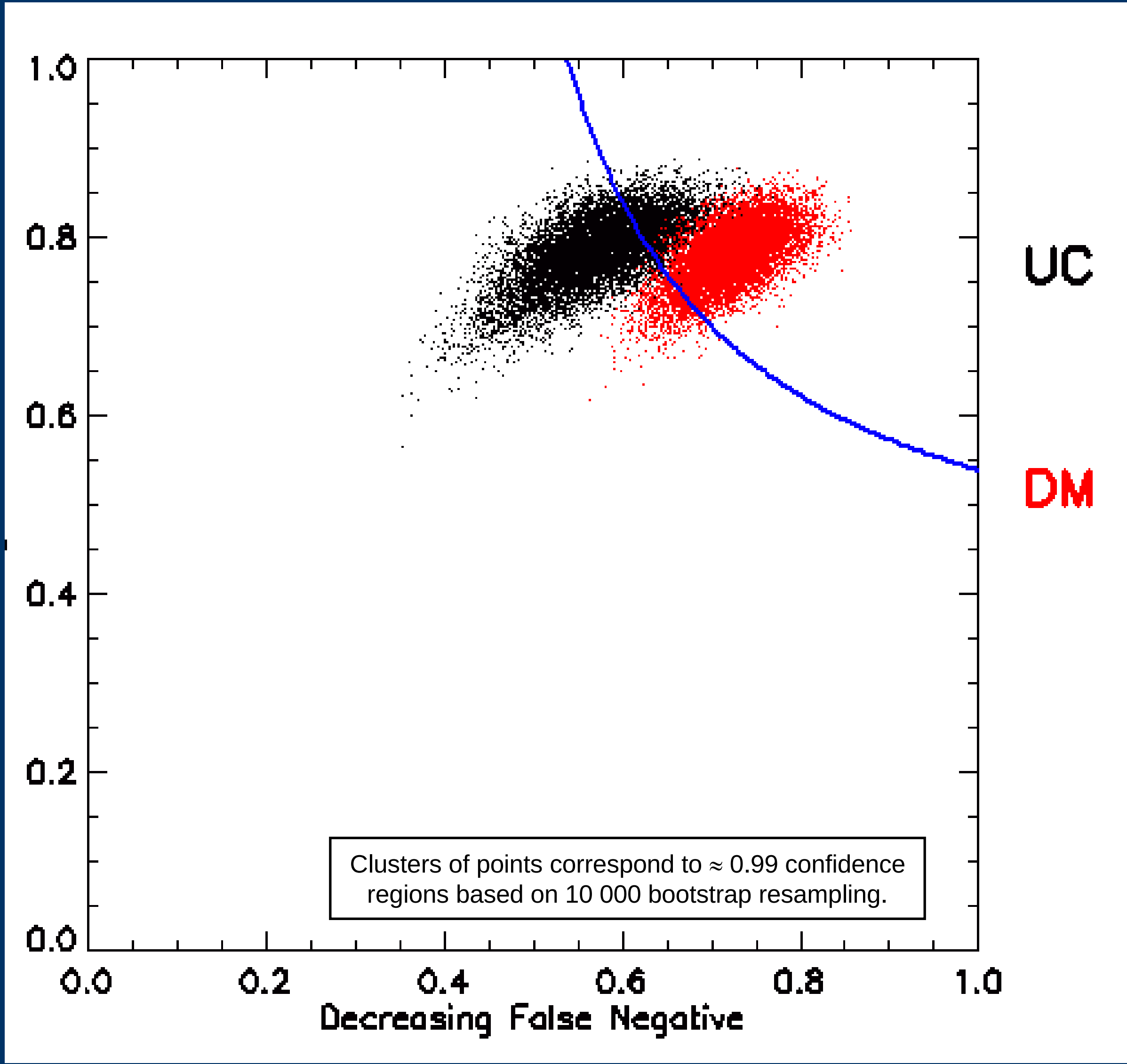


based on 51 releases

Example Application 2: Urban HPAC Baseline Mode (Urban Canopy – UC) , Urban Dispersion Model Mode (UDM), and the *Urban 2000* (Salt Lake City) Field Experiment

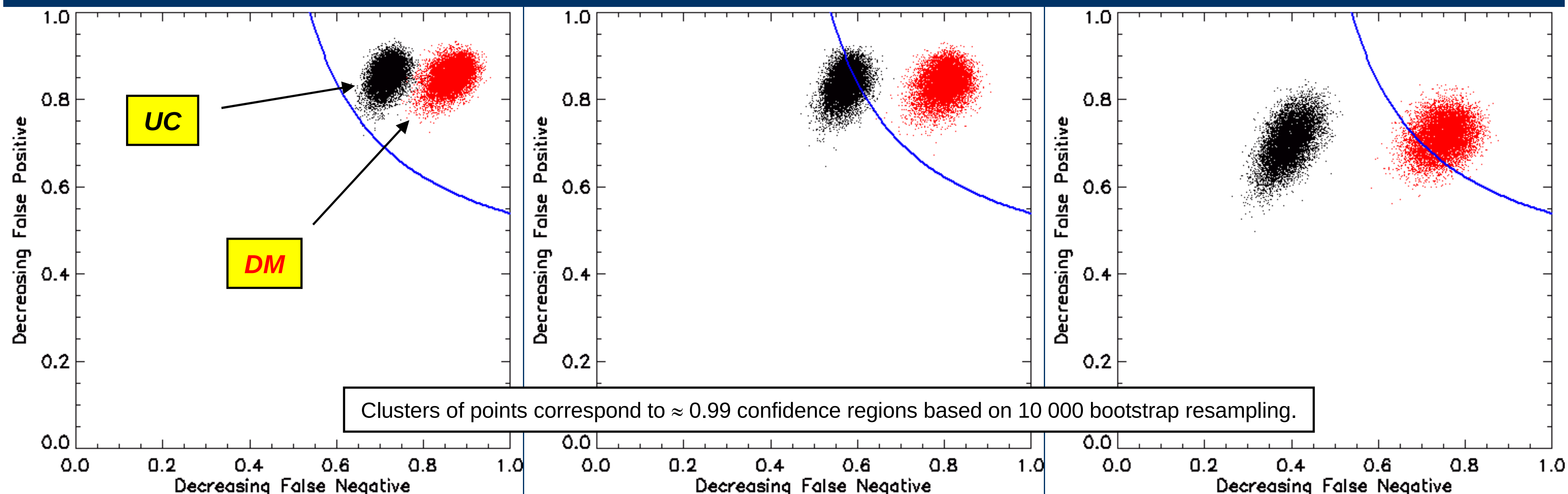
T = 30 ppt
≈10 × background
≈ 2 × MLOD

Based on HPAC (UC and DM) predictions of *Urban 200* with the "Raging Waters" upwind profile meteorological input option and 18 releases



Example Application 3: Urban HPAC Baseline Mode (Urban Canopy – UC) , Urban Dispersion Model Mode (UDM), and the *MUST* Field Experiment

T = 0.01 ppm	***T = 0.10 ppm***	***T = 1.00 ppm***
≈ 100 × sampler limit	***≈ 1,000 × sampler limit***	***≈ 10,000 × sampler limit***



Based on HPAC (UC and DM) predictions of *MUST* with the "SONICs" meteorological input option and 37 releases

MUST = Mock Urban Setting Test, Dugway Proving Ground 2001

Additional Comments and Caveats

- **As would be true for any model evaluation technique, interpretation of results must be carefully considered**
  - Field trial experiments typically include high quality source term and meteorological information that will not necessarily be available for actual applications
    - » in a sense, such evaluations might be thought of as the model at its "best"
  - It is important that supporting analyses be conducted as part of any evaluation. For example, MOE values can be computed
    - » at a few different low threshold values (typically we vary by factors of about 100),
    - » as a function of downwind distance and time after the release
    - » using sampler weighting or interpolation procedures to assess results in the context of actual area sizes (where feasible), and
    - » by considering notional scenarios (that match up well with the field experiment ,where plausible) in order to consider the effects of actual agents – "effects filtering".

- **Interpretation of the JEM accuracy requirement in terms of the MOE and NAD satisfies the need for assessing this requirement for acquisition / program management decisions (e.g., when to shift resources from improving one aspect of the system to another) in the context of actual user needs**
  - Evaluations based on "armax", crosswind integrated concentration, and average concentration do not allow for this user context
  - Other scoring functions (for the 2D MOE space), have been developed that can be used for other purposes (e.g., doctrinal development)
    - » an important family of scoring functions has been developed that allows the user to weight the risks (trade-offs between false positive and false negative fractions) as appropriate to his or her application and mission

Summary

- **Issues with the application of the JEM accuracy requirement to future evaluations have been identified**
  - Not likely to be achievable or even reasonable
  - Not what the user wants, needs, or requires
    - » user's typical interest is in locations (times) where a hazard threshold is exceeded – a "hazard area"
- **Proposed solution**
  - Evaluate JEM hazard predictions user-oriented 2D MOE and actual field experiment observations
  - Assess MOE based on hazard regions, i.e., exceeding a threshold
    - » how well does the model predict the locations where a low-level threshold is exceeded
  - Use normalized absolute difference as a straightforward measure of accuracy that is directly related to the requirement
- **Example studies suggest:**
  - HPAC, and hence JEM(HPAC), can reasonably be expected to pass this accuracy threshold for simple (no complex terrain), short-range, open field experiments (e.g., *Prairie Grass*)
  - More complex situations, for example, urban environments, may require additional model features (recall baseline HPAC versus UDM mode comparisons for Urban 2000 and MUST)

User involvement in JEM evaluation remains crucial for success.